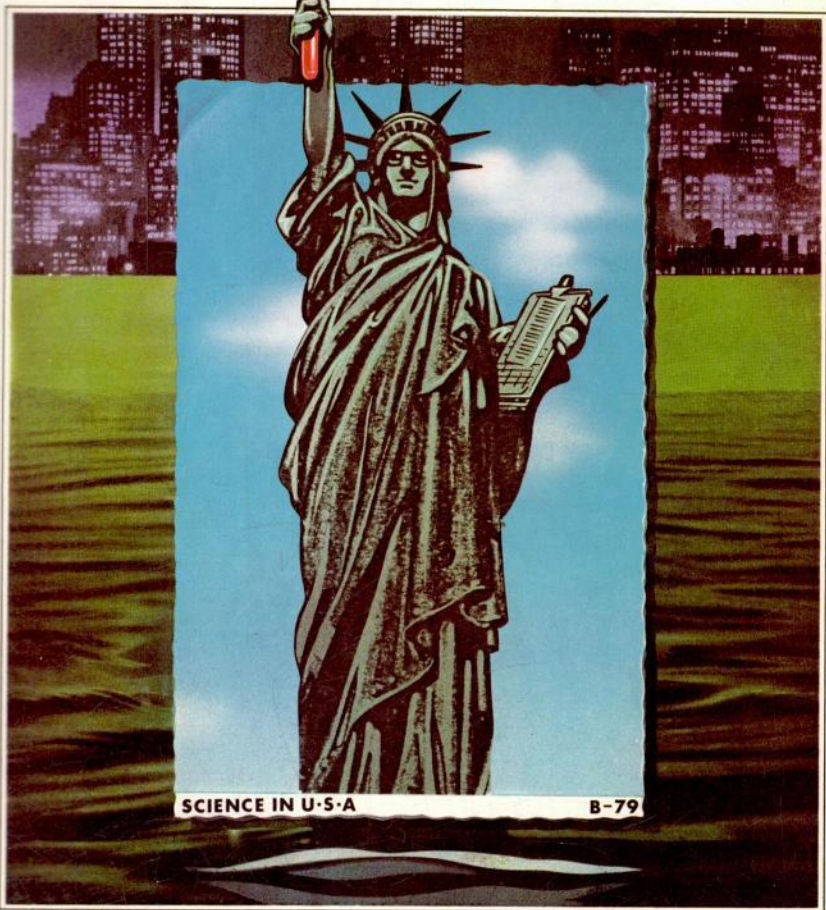


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SCIENCE IN U.S.A. 8-78

Science in the United States has reached new crossroads. The 1980s open with growing debates on the value of past technological achievements, and on the role of science and technology for the future. This week *New Scientist* focuses on some of the critical issues involved.

Cover by: Mick Brownfield

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# Comment

## Chip talk goes on

Last week's National Economic Development Council meeting (see *This Week*, p 143) highlighted the reassuring fact that everyone—government, employers and trade unions—agrees that new microelectronic technology is a "good thing". It should be introduced into British industry to arrest the country's decline and to safeguard employment, they agreed. Beneath the smooth words of consensus, however, there is very little to suggest that we are going to see such action.

The thesis agreed by all sides is that new technology makes industries more efficient, increases competitiveness, helps to boost output and so keeps people in work. The fact that this view may be incorrect is just one of the unpleasanties that looms ahead. We may be moving into a period where extra productivity through technical advance increases faster than economic growth—a process that leads to what economists call technological unemployment.

Let us suppose, however, that the "consensus" view is correct and that Britain's problems will be solved by the introduction of the new techniques: we then face two immediate issues. First, companies must want the changes, and so must employees. NEDC director-general Geoffrey Chandler has told the government it should institute technical "awareness programmes" across the board. This hardly convinces observers that firms are straining at the leash to cut their teeth on chip-based techniques.

Resolution of the second difficulty—to get workers to agree to the new ideas—could be helped by the idea of "technology agreements". Under these, management and labour force would get together to talk about the introduction of new technology to smooth out changes in working patterns and allow for possible redundancies. But there are minefields ahead. Both the Confederation of British Industry and the government like the idea of these agreements. However, the government is faced with a specific demand from civil service unions for a technology pact that includes a clause freezing the number of job opportunities in the Civil Service. The government is explicitly against this. To agree to the principle of technology concordats while disagreeing on fundamental issues such as this makes the whole exercise meaningless.

Very much concerned with getting people to accept change is the issue of training. The TUC wants a "massive effort", partly sponsored by government, to train skilled workers. The government and the CBI are against this, preferring that firms, not Whitehall, should have the responsibility of instructing employees. Recent experience in the computer industry, however, suggests training in certain key areas cannot be left to industry. It is estimated that Britain is short of about 20 000 software specialists. Yet companies invest very little in training because they fear that their employees, once brought to a high standard in software skills, will leave. This is a perfect example of where government involvement is crucial.

Peter Marsh and Malcolm Peltu

## Climatic cause for concern

One of the talking points at this year's annual meeting of the American Association for the Advancement of Science, as in recent years, was the likelihood of a warming "greenhouse effect" produced by a build-up of carbon dioxide in the atmosphere. So far, most predictions about the consequences of this have been rather vague, accurately reflecting deficiencies in present-day detailed understanding of the mechanisms of climatic change. But a team working

at the Climatic Research Unit at the University of East Anglia, has now come up with a more detailed scenario for a warmer world (*New Scientist*, 3 January, p 15). The crucial importance of this study is that it pinpoints the way rainfall patterns might change as the world warms; and the scenario suggests, in particular, that the changes associated with the warming would bring drier conditions to most of the US, across Europe, and over the great grain-growing regions of the USSR.

With the current strains on world food markets, and the political repercussions of massive purchases of grain by the USSR, it is difficult to see how a shift into the climatic regime sketched out in the latest scenario could be accomplished smoothly, from the viewpoint of the inhabitants of the regions affected.

In this context, the plea from the East Anglia team that its work highlights the need for more research should be taken as something more than the conventional obeisance from academics to the holders of the purse strings. Just under a year ago, a meeting at the World Meteorological Organisation's headquarters in Geneva highlighted the carbon dioxide problem as a major cause for climatic concern. Events since then have confirmed the accuracy of this assessment, and some idea of the specific problems involved is now emerging. And yet, no serious effort is being made to curtail the destruction of our dwindling reserves of tropical forest, the main cause of the carbon dioxide build-up in the past hundred years, or to require fossil-fuel power stations to scrub carbon from the gases they release.

Without doubt, continued increase in atmospheric carbon dioxide is one of the major environmental problems of the new decade.

John Gribbin

## Finniston threatened by caveats

There has been an overwhelmingly "non-negative" reaction by engineering institutions, industry, the educational establishment and the unions to Sir Monty Finniston's report into the engineering profession (*New Scientist*, 10 January, p 80). This could be put down to the skill with which Sir Monty and his team framed recommendations that drew from the engineering profession such comments as "just what we advocated" and "what we have been striving for for years". But it could also mean that the ultra-conservative engineering establishment is biding its time and brushing up its vested interests.

Many of the "positive" statements made by bodies such as the engineering institutions contain caveats. Nothing unreasonable about that. But isn't it suspicious that many of them recommend caution or no action? The Institution of Mechanical Engineers, for example, says it already knew everything that Finniston says, that his proposals would be "unduly costly" and that the new Engineering Authority that Finniston proposes would not do anything that the present establishment could not. It doesn't explain why it did not do it before now.

The government says it will act fast on Finniston, bringing legislation before parliament this autumn. That is also when the Department of Education and Science is holding a conference of possible changes to the education of engineers that Finniston proposes. Many institutions appear to be pinning their hopes of delaying change on that conference. If the government really means Finniston's report to do better than those of his dozen or so predecessors it should act on the main recommendations before the engineering profession's own torpidity settles its own, and the country's, fate.

John Stansell



# Thisweek

## US research fuels Soviet invasion

Malcolm Peltu

President Carter's ban on the sale of computers to the Soviet Union may have come too late to prevent US-made computers already in Russia from being applied to military activities, possibly even in assisting to build lorries used in the Afghanistan intervention which prompted the trade ban. The US Department of Commerce is examining two specific allegations about the use of American computers in Russia. CIA intelligence reports have indicated that lorries made at the Kama River factory, which uses IBM computers to aid production, were sent into Afghanistan. And it has been alleged that a Sperry Univac system installed near Moscow last year, supposedly for use in synthetic rubber research, could have been diverted to help build a new supersonic bomber.

IBM computers were introduced to the Kama River factory in 1971. According to Peter Krass of the *Technology News of America* information service, a report prepared last summer confirmed allegations by American officials that some of the Kama River lorries were being used for military purposes. However, a row broke out in the US Department of Commerce over this report, which had been produced by Lawrence Brady, deputy director of the department's Office of Export Administration. Last November, says Krass, the department distributed a letter claiming that Brady's report was self-contradictory over whether there had been any specific agreement prohibiting such military use. Brady, however, felt that his report was being hushed up because it was inconvenient to the government at that time.

The Univac computer highlights the technical difficulties of trying to control international trade in modern computers.

The medium-powered computer was sold to the West German subsidiary of a Swedish software company for subsequent resale to the Soviet Institute for Design and Research in Synthetic Rubbers, which is based outside Moscow—and close to a Tupolev aircraft plant.

The Univac machine had been through the normal vetting procedure in the US government and Cocom, the NATO committee which monitors high technology trade with Communist countries. But the crucial factors in any computer system is not just the hardware but the software programs which instruct the machine how to solve particular problems. Supplied with the Univac system is a software package which performs stress analysis calculations suitable for aircraft wing design. This software was developed by the Swedish company whose subsidiary acted as an agent for

the sale—and Sweden is not bound by NATO conventions.

Software is particularly important because it exploits the main attraction of computers as *general purpose* systems, capable of solving a variety of problems. A machine initially used in one role such as rubber research could therefore be altered to another function, perhaps wing design, given the right software.

The Tupolev aircraft factory is involved in the design and manufacture of the "Backfire" supersonic bomber, which was downgraded to a medium-range aircraft as part of the now-suspended Salt II disarmament talks. Recent "spy" satellite information, however, indicates that a new supersonic delta wing plane, roughly equivalent to the shelved US B-1 bomber, has already undergone test flights.

In accordance with American traditions of close interaction between industry and government, ex-officials from technology companies such as IBM hold important government positions, while the head of Sperry Univac, J. Paul Lyet, is also chairman of a White House committee examining the sale of high technology to Russia. Tom Watson, former chairman of IBM, is currently the US Ambassador to the Soviet Union. He was recalled to Washington to discuss the consequences of the Afghan invasion. US Defense Secretary Harold Brown is a former IBM board member and Cyrus Vance, Secretary of State, is a former IBM director. There are fears that this close relationship may lead to conflict between firms anxious to push new trade agreements and government foreign policy.

Neither IBM nor Univac is making any detailed comment at this stage. ▶



"Lousy yankee computer! We're supposed to be in Tehran!"

## Shuttle slows pace in space race

The space shuttle may not make its first test flight into orbit until the end of this year—15 months later than the initially planned date of September 1979. NASA's deputy administrator, Dr Alan Lovelace, said in London last week that the present revised schedule is unlikely to be met and that the launch date could well slip from June to September/October or later.

The two major reasons for the delay are problems with the Orbiter's three main rocket engines and with the thermal insulation which prevents the vehicle from burning up during re-entry into the atmosphere. About three-quarters of the work necessary to clear the Orbiter Columbia for its first mission has been completed, but some 10,000 insulating tiles remain to be attached.

Lovelace admits that NASA concentrated too much on the tiles' thermal-insulation properties and underestimated the mechanical strength that would be required. Natural felt made from rabbit fur obtains its strength from minute barbs on the individual hairs, which ensure that the material meshes together.

The shuttle's tiles are backed by a "strain-isolation pad" of felt constructed from Nomex, a manmade fibre which has no such barbs. Hundreds of needle holes had to be punched into the Nomex felt to bind it together, but this resulted in local stress concentrations which prevented the pad from spreading mechanical strains evenly across the tile.

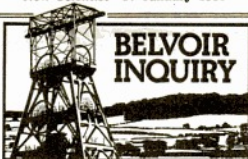
The solution now adopted is to impregnate the felt with a silica slurry which, when set, provides the necessary extra strength. Every accessible tile on the Orbiter is now being pull-tested by a vacuum chuck, operating at a pressure of 14 lb/sq.in, to ensure that it will stay in place during flight. When such a method is not possible, the tiles have to be removed and tested to twice their design loading before being replaced.

Columbia is due to be moved from the Orbiter Test Facility to the Vertical Assembly Building (VAB) at the Kennedy Space Center in April. In the VAB the massive external propellant tank and the solid-propellant rocket booster motors will be attached to Columbia before it is

transported to Pad A for its "flight-release firing"—a 20 second run of the main engines. It is at this point that further delays could occur.

When Columbia is eventually boosted into space, the astronauts on board may have to get out and repair damaged tiles before they can re-enter. If monitoring instruments show heat build-up, then the astronauts will attempt to plug any gaps with a filler compound. Lovelace stresses, however, that any failure might damage the vehicle's skin but would not endanger the crew.

The cost of the shuttle programme has now risen to about \$8000 million at 1979 prices, compared with the projected \$5200 million when the project started in 1971. Lovelace was unwilling to disclose details of NASA's budget for the next year, which will be revealed by President Carter on 26 January, but shuttle delays and cost increases could well endanger other projects. The US Office of Management and Budget has recommended that the proposed flight to the Halley and Tempel-2 comets (*New Scientist*, 10 January, p 66) should be abandoned or cut back. □



## Department of Energy in Belvoir hot seat

Roger Milne

Last week the Vale of Belvoir proceedings resumed after the Christmas recess and for 2½ days British energy policy and the latest set of energy forecasts drawn up by the Department of Energy were under scrutiny. Philip Jones, the civil servant responsible for energy policy coordination, was under fire on a variety of issues—from conservation to economic growth.

Despite an estimated initial cost of nearly £800 million to sink the three new pits, the Department of Energy supports the economic case for winning the North East Leicestershire coal reserves.

Energy forecasts and a note on energy requirements supplied to the inquiry by the department, indicate broad government support for coal, together with energy conservation and nuclear power, as the three key elements in the national energy strategy. "All three will be complementary," says the department note, "with coal playing a key role in the progressive replacement of oil." It is already substituting for oil to the maximum extent feasible in electricity generation, the inquiry was told. As oil prices rise, new markets are expected to open for replacing oil and non-premium gas used in industry. With increasing pressure on indigenous gas supplies, another source will also be required. Coal will play a growing part in this and other longer term markets for synthetic fuel and chemicals. Demand for coal during the 1990s is likely to be at least at present levels and the chances are that the need to use and produce coal will be rapidly rising by the end of the century.

Taking everything into account, the DOE is anticipating a total energy demand of between 445 and 510 million tonnes of coal equivalent (mte) by the year 2000, and at least between 410 and 455 mte by 1990. Indigenous coal will supply between 137 and 155 mte by 2000, (127 and 138 mte by 1990). So the department foresees an energy shortfall.

Jones made it plain that there might be some imports of coal, but he was adamant that it was not government policy to rely on this source of fuel. National Coal Board opponents stressed the growing world trade in coal, and wondered if imports would make better economic sense than developing new UK reserves which, if left in situ, might conceivably be worth more as the energy-hungry decades after 2000 unfold.

Jones found the going very heavy indeed when the inquiry tried to tease out the assumptions on which the fore-

casts were based, together with an assessment of the impact of the recently announced nuclear programme. It emerged, for instance, that Energy Secretary David Howell has a more optimistic view of the role of renewable energy sources than his advisers. Speaking toward the end of the Commons debate following his announcement of government nuclear intentions just before Christmas, Howell claimed that aerogenerators, wave power and tidal barrage could provide some 10 mte by the year 2000. Jones, on the other hand, told the inquiry that since the Energy Green Paper of 1978, which also suggested a similar figure, "difficulties have emerged and we would not now see a figure of that order being available in the year 2000". Asked whether the Energy Secretary was being misleading in his Commons statement, Jones replied "Well, as my Secretary of State says, it is possible. You asked my view about realism and whether it is likely. I would still say in my judgement that I do not think it likely that 10 mte will be available from the renewables."



On the question of nuclear energy, Jones made it clear that the pre-Christmas announcement of what amounts to a 15 gigawatt programme, or one new power station a year from 1982, would leave a 15 gigawatts shortfall of the "target" of a generating capacity of 40 gigawatts by 2000.

Under cross examination Jones agreed there were two implications—that coal could have a greater contribution to make for electricity generation in 2000 and that the nuclear programme might have to be stepped up "significantly".

One of the biggest question marks which emerged during Jones' two-day "grilling" concerned future UK economic performance and the effect this will have on energy needs. The energy forecasts assume a demand based on a rate of growth in the economy of between 2 and 2.7 per cent annually. Jones said his department had also looked at the implications for energy demand of growth of only 1 per cent (our current performance) and of 4 per cent. He said that if the UK managed an annual increase in GNP of only 1 per cent the coal requirement in 1990 would be 110 mte and in 2000, 115 mte. A report on this from Harwell is expected this summer.

► Univac has issued a statement that its initial investigations have not found evidence to substantiate the allegations but that it will fully cooperate in government investigations.

In the past, trade with Communist countries has been governed by a ruling relating the power of machines sold, with the larger machines considered to be of greater military value. But advances in microelectronics, which has increased the power and reduced the size of computer processors, has made the interpretation of such a definition very difficult, particularly as it is possible to link microprocessors together to develop a high powered machine from low powered components.

A few years ago, Carter imposed a ban on sales of computers to any company which he felt was infringing human rights—and that included the Soviet Union, although some trade has taken place since then, such as the Univac computer contract.

The current US trade ban will be imposed on the sale to another country of any computers which might be re-exported to the Soviet Union, to avoid a similar deal to the Univac third-party sale. If a non-American computer manufacturer sold a major system to the Soviet Union, the US government would consider barring the sale of computer components, say microprocessors or computer memory, to that company. □

## The black and white of IQ testing

University of California psychologist Arthur Jensen gained instant notoriety in 1969 when, in an article on remedial education, he asserted that blacks are genetically less intelligent than whites. His claim, based on IQ tests, encountered virulent opposition from Liberal academics and left-wing students alike.

Last week, Jensen published his major response to the critics, a 774-page book entitled *Bias in Mental Testing*, the Free Press, (a division of the American Macmillan Publishing Company, 866 3rd Avenue, New York 10022, \$29.25). Jensen says that IQ testing does indeed have merit in measuring intelligence, despite a wave of current efforts to discredit it.

Jensen sets out to destroy the contention of his critics that IQ tests are culturally biased against non-whites. Citing a vast array of statistical data, he suggests that black children actually do better in items specifically related to "white culture" than on culturally neutral tests. Jensen also claims that the major tests used by schools, businesses and the armed services predict the future successes of the test-takers very accurately, that black children have a tougher time than their white counterparts in reasoning conceptually, and that the well-documented difference of about 15 points between black and white averages on the tests should be attributed to a developmental lag. □



## Earthquake threat shakes nuked drill inquiry

Britain's first public inquiry into plans to test drill rocks to see if they are suitable for the storage of nuclear waste should be postponed so that evidence on the two recent earthquakes that hit southern Scotland can be prepared and submitted. This was the forceful plea lodged by objectors at a pre-inquiry meeting held in the Scottish town of Ayr recently.

The inquiry arose because the UK's Atomic Energy Authority was refused permission by the local authority to test drill an area above Loch Doon in the Galloway Hills in order to investigate the properties of the hard granite deposits below. The ultimate aim of the UKAEA's study was to test the suitability of such geological formations for the dumping of nuclear wastes and local authorities felt this would lead to an application to dump at the Loch Doon site. The UKAEA appealed the decision, leading to an inquiry under the auspices of the Scottish Office, during which the authority and six conservation groups will present evidence.

The objectors argued that the evidence on the Earth tremors should be presented to the full inquiry—due to open in mid-February—because the proposed test site was close to the epicentre of one of the vibrations. They claimed that evidence on the quakes would be vital if the full inquiry was to cover comprehensively all the issues involved in nuclear waste disposal.

The inquiry's chairman or "reporter", William Campbell ruled, however, that the full meeting could not be delayed. This defeat for the objectors came after their recent victory in persuading the chairman to widen the scope of the original terms of reference for the inquiry. Initially, the Scottish Office had wanted debate rigidly restricted to the United Kingdom Atomic Energy Authority's planning application to test drill in the Galloway Hills. No debate on the possible storage of waste at the site was going to be permitted.

However, after very strong lobbying, Campbell agreed to permit evidence on the possible existence of better sites in the area, and the likely effect of the drilling on the local economy, wildlife and environment as well as the ultimate threat of nuclear dumping. He refused, though, to cast the net wide enough to take in alternative methods of disposal or any issues that involved "sophisticated technology".

Most of the protesting groups welcomed this latest move. Labour MP for South Ayrshire George Foulkes said he was pleased Campbell had agreed "to open it up a bit. This is a bigger concession than we expected," he said.

But not all the objectors were happy. The Town and Country Planning Association criticised Campbell for continuing to restrict the debate so tightly. What was needed was a full-scale national pub-



The test sites cover a wide area between picturesque Loch Doon and the hill

lic inquiry into the whole question of nuclear waste disposal, said TCPA representative Kelvin MacDonald. "The Scottish Office should postpone or abandon the inquiry until it reconsiders the terms of reference and makes all the national and international evidence available. The inquiry should be considering national policy and the government's research programme, without any reference to particular sites," he said.

The meeting was told that the Scottish Development Department would be presenting the full inquiry with a statement of the government's current policy on nuclear waste disposal, and an update of the programme of research that has been under way.

But there was uproar when the UKAEA announced that it would not be presenting details of research it has already completed on a test drilling site in Caithness. A UKAEA representative originally claimed that the research report was not

ready but then had to admit that he had made a mistake when one of the objectors held up a copy of *Atom*, which revealed that the report had been assembled last spring.

Professor Ivan Tolstoy, speaking for the Scottish Conservation Society, one of the principal objectors, told the meeting that he would be presenting evidence to show that the whole question of test drilling was irrelevant. "It is possible to determine before drilling that the sort of rock and the present vitrification processes used just don't fit together," he said. The chairman agreed to accept the evidence because it was sufficiently close to the point.

If the UKAEA wins the inquiry and finds that the rock is suitable for storage it will still have to apply for planning permission to dump waste there. The full inquiry starts on 19 February and is expected to last for two to three weeks. □

## Rosy future for engineering graduates

According to a forecast\* issued this week, the total number of graduates of British universities and polytechnics is expected to pass the record mark of 100 000 for the first time. There will be about 81 000 first degree graduates—63 000 university, 18 000 polytechnic—and 20 000 higher degree graduates, almost all from universities. The total of 101 000 is 4 per cent up on 1979. But the optimistic message of the report is that this may not mean more unemployment among graduates as a whole. On the contrary, those in certain disciplines should find it easy to get a job.

The balance between supply and demand has always differed from one subject to another and in recent years the range has tended to widen. At one extreme, there are two or three jobs available for every mechanical or electrical engineering applicant, even though the numbers graduating in these disciplines are at record levels. At the other extreme, there are many more graduates than there are "relevant" jobs in the biological sciences, arts subjects and certain social studies. This "polarisation" means that a graduate's job prospects depend more on the subject studied than on his or her academic performance.

Just over half of the total output—

some 53 000 graduates—are expected to be looking for jobs this year, an increase of 8 per cent on last year. There are several reasons for the gap between the number of students passing out of university and of job-seekers. Many first degree students stay on for further study or training and only enter the job market when this is completed. But there is a slight reduction in the expected number of research council grants, owing to expenditure cuts; so for the first time, there are signs of graduates not taking up awards offered, presumably because of poor academic career prospects.

Also not joining the job market are those graduates who start teacher training courses. Unfortunately, the report points out that a considerable number of places on these courses continue to be unfilled, particularly in chemistry, physics and mathematics. If this trend continues, it bodes ill for the future supply of sixth-formers suitably qualified for physical sciences, engineering and technology higher education courses.

The forecast considers that a decline in jobs for graduates in the public sector will be more than offset by those in the private sector, giving an overall demand for graduates of about 4 per cent higher than in 1979. The recovery in Civil Service recruitment which occurred last year is expected to reverse once again and the intention of local authorities, major employers of graduates, is uncertain. □

\*Graduate Supply and Demand—1980 jointly produced by Association of Graduate Careers Advisory Services, the Central Unit for Careers and Appointments Services and The Standing Conference of Employers of Graduates.



# Thisweek

continued

## Brickworks plan emits a bad odour

The Environmental Services Committee of Bedfordshire County Council must soon decide what to do about an application by the London Brick Company (LBC) to replace its 98-chimney brickworks complex in Bedfordshire's Marston Vale with two new "superworks", each with a capacity of 10 million bricks per week. The new works would have fewer but taller chimneys—from 120 to 150 metres high, depending on the local topography.

The Bedfordshire council does have a detailed report of the environmental effects of the brickworks, prepared at a cost of £25 000 by the consulting firm of Cremer and Warner. But strong opposition to LBC's proposals comes from several sources, and particularly from PROBE (Public Review of Brickworks and the Environment), a committee chaired by the Marquis of Tavistock, and including in its membership three local MPs and Philip Hendry, leader of Bedfordshire County Council. They claim not enough is known about fluoride pollution from such tall chimneys.

PROBE, which held its first meeting at the House of Commons on 25 July, 1979, is not opposed to the building of new brickworks but is concerned about the lack of information on many aspects of pollution from LBC's chimneys, particularly fluoride emissions, and wants to see a full-scale public inquiry into the company's plans. A number of members of the committee met with senior civil servants at the Department of the Environment in the autumn, and highlighted the need for further information about the extent or content of LBC's emissions. The DOE has instituted its own investigation and its report should be available soon, but PROBE insists that nothing short of a full-scale inquiry will be satisfactory.

In the meantime the committee has set up its own sub-group, with the guidance of a local doctor, to look into the possibility that breathing, muscular and arthritic problems have increased in the area around the existing brickworks. Other objections from residents in the area are based on amenity issues, and they have formed their own action group, GASP (Group Action to Stop the Pit), to fight the proposal.

The report from Cremer and Warner is inconclusive about the need to reduce fluoride concentrations. It claims there was insufficient evidence on which to base an opinion, particularly about whether a reduction in the levels of fluoride would be desirable to protect grazing animals. It concluded that although present levels had no significant effect on human health, local vegetation might be affected. Nevertheless, it believes that techniques for selective fluoride removal should be examined. The report recommends that planning permission should be deferred or rejected for the construction of conventional Hoffman kilns as proposed by LBC, and that alternative kilning techniques should be

investigated by the company under Alkali Inspectorate supervision.

These recent developments are the latest in a long-running controversy that started over 40 years ago. In 1935 veterinary practitioners near Stewartby called in expert assistance to establish the cause of a mysterious lameness of cattle in the area. Their report was not published until 1948, when it was shown that the disease was fluorosis, and that the outbreak coincided with the expansion of the brick-making industry in that area over



London Brick Co.

the past decade. The issue surfaced again in 1964 with the publication by the Ministry of Agriculture, Fisheries and Food of a report of K. N. Burns and R. Allcroft entitled *Fluorosis in Cattle*. This report showed that out of 43 farms studied in the Bedford area, 19 were affected to a greater or lesser degree by this disease.

One of the few farmers in the area who is not a tenant of the LBC is Peter Goode of Ridgmont, who has lost some of his cattle as a result of fluorosis. Goode was largely responsible for the formation of PROBE of which he is secretary. He

is highly critical of the role of the Alkali Inspectorate who, as the responsible public watchdog has, he says, done next to nothing. Goode told *New Scientist* that "The Alkali Inspectorate in 1964 appeared to be either entirely ignorant of the Burns and Allcroft report or were deliberately trying to draw attention away from it, since the alkali inspector's report for that year contained the statement that ground level concentrations of sulphur and fluoride compounds (in the Bedford area) continued to be satisfactorily low." This statement, says Goode, has been repeated in the annual reports

Britain's tall stack policy has been blamed for long range sulphur dioxide pollution. Will it spread fluoride in the same way?

of the Alkali Inspectorate every year since then.

This is not the first time that the Alkali Inspectorate has come in for severe criticism over its apparently complacent approach to emission problems. Goode says that it is interesting to note that the late Richard Crossman, in volume one of his diaries, published in 1966, says on p 623 "By and large I found that nearly all my technical advisers were passionately in favour of the producer, and against the amenity lobby; this was particularly true of the Alkali Inspectorate." □

## Test-tube baby clinic approved

The first United States test-tube baby clinic has received official approval, and will open its doors within about two months if it can overcome a legal rear-guard action by anti-abortionists and other foes. The clinic, at the Eastern Virginia Medical School in the city of Norfolk, gained the approval last week of the state of Virginia's health commissioner Dr James Kenley, who certified that "in vitro fertilisation will provide another means to rectify infertility problems for those couples for whom existing solutions are not adequate or acceptable."

The obscure, six-year-old medical school won first place in the race to start an in vitro fertilisation clinic largely because it does not use federal funds. Debate within the government over the test-tube procedures has delayed the efforts of more prestigious medical schools, such as those of Cornell and Vanderbilt Universities, to open their own clinics. But the Eastern Virginia Medical School insists that it will

provide quality care for childless couples, who will pay between \$3000 and \$4000 for two attempts at implantation of an ovum fertilised in the test-tube. The school has taken on a team of five fertility experts from the highly regarded Johns Hopkins University Medical School. The team has already started to monitor women chosen for the procedure from among more than 2500 applicants.

The assurance of quality medical practice has not been enough for foes of the clinic, and particularly local anti-abortion groups. (See this issue, p 147.) They express concern that the researchers will either discard imperfect embryos or—worse—use them for research, and also that recipients of the fertilised ova will have the right to abort their fetuses should examination show up abnormalities. Medical School officials insist that their fears are groundless, and that medical ethics committees will control all the clinic's work. Nevertheless, their opponents have vowed to prevent the clinic opening by legal means. □

## Firms fail to get to grips with chips

The British government should launch a series of "awareness programmes" in specific areas of new technology to help industry to become more competitive. It should also assist innovative firms by making a big effort to buy their products for public use. And small technology-based firms, which often find it difficult to obtain financial backing from private sources, should be helped by an official scheme to channel loans to them. Geoffrey Chandler, director-general of the National Economic Development Council, made these points last week as part of a major effort to spell out to British firms why they have failed dismally to get to grips with new technology.

According to Chandler: "There is a high general level of awareness of the contribution advanced technologies can make to improving manufacturing efficiency and to enhancing the value and capability of products. By contrast with competitors, however, the actual take-up by industry remains sluggish." Chandler highlighted the importance of channelling microelectronic techniques into two specific areas—office equipment and machine tools. This is because of the crucial contribution that these products can make to other areas of business.

For instance, NEDC has found that lack of application of computer-based office equipment is partly to blame for the failure of an important group of companies to deliver their goods on time. Only 18 per cent of firms manufacturing radio, radar and navigational goods meet their delivery dates, according to a NEDC survey which says the firms involved could increase efficiency with the help of computers. However, NEDC praises the forward attitude of the food and

drink and coal mining industries.

In the area of automation and instrumentation, the NEDC says firms "often remain unaware of the need to automate until they are well behind their overseas competitors". In machine tools "the UK, despite having been a leader in direct numerical-control integrated manufacturing systems in the 1960s, has since lagged in the technology, and particularly in user acceptance, well behind the US, Japan and the two Germanys".

British firms also are behind in fork-lift trucks, an important component in new warehouse systems. "It would appear that UK companies will need to develop a defined strategy as to the market sector they are capable of supporting," NEDC says. In mechanical handling—cranes, lifts and conveyor belt systems—foreign firms are applying new technology very fast and there could be "real dangers of rapidly increasing imports with consequent low employment opportunities".

The over-riding theme in the NEDC documents is that Britain must use new technologies to keep its manufacturing industry strong. If it does not, not only will the country weaken economically but unemployment will rise drastically. Here there is full agreement from the economic committee of the TUC, whose special report on the effects of microelectronics was also released last week. The committee says: "British industry must apply microelectronics in production processes if the deindustrialisation of Britain is to be stopped." It also calls for a massive training programme to adapt skilled workers to new processes, and to teach even non-scientific students the implications of chip-based technology. □

## New money freshens US wind research

The US Congress recently voted funds which could lead to the rapid commercialisation of wind turbines. The plan is to build 800 megawatts (MW) of installed capacity by 1988, of which 100 MW would be provided by small windmills and the rest from multi-megawatt machines like MOD 2 and their successors (designated MOD 5). All that is now required for this massive investment, approaching \$1000 million, to go ahead, is that it receives approval in the Senate. It is confidently expected that the green light will be given within the next few months.

The US Department of Energy has invested \$60 million per annum for the past two years in order to build a number of prototype large windmills and carry out R&D to back up this programme. Last summer, the so-called MOD 1 machine (60 metres in diameter, generating 2 MW at peak output) began operating in North Carolina and next autumn the first 2.5 MW, 100 metre diameter wind turbine is expected to generate electricity in Washington State. This is intended to be the first of three turbines installed on the same site to

herald the world's first multi-megawatt windmill cluster. It was the encouraging results of this programme, that convinced the US Congress to go ahead. □



This 1 MW NASA prototype wind generator is tiny compared with future models

## Seven Days

6 January to 12 January

**7 JANUARY** Five chemical companies that manufactured the defoliant Agent Orange charge that the US government's negligent misuse of the chemical is responsible for disabilities among Vietnam veterans. A Dow spokesman says the companies are not admitting the agent is harmful, properly used, and they are convinced that the chemical caused no harm in the US, where it is used as a herbicide.

**7 JANUARY** The UK's Health and Safety Commission proposes that certain potentially dangerous substances, such as asbestos and unsealed mercury, should be banned in materials and equipment provided for home workers. The scheme is that companies or individuals giving such work should send information to their local inspector twice a year about the nature of the work and the materials used.

**7 JANUARY** The American Department of Energy gives Westinghouse a \$4.4 million two-year contract to develop an integrated energy system powered by an air-cooled phosphoric acid fuel cell. Westinghouse says the work could lead to a fuel cell system that can provide electricity, heating and air conditioning for commercial and residential buildings.

**8 JANUARY** Alexander Ginsberg, the Soviet dissident, announces that he is seeking an urgent meeting with Lord Todd, president of the Royal Society and other members of the British delegation attending an international scientific conference in Hamburg in February under the Helsinki agreement. He wants to persuade the British delegation to raise the case of Dr Yuri Orlov, the physicist serving a seven year sentence in a labour camp for monitoring Soviet observance of the Helsinki agreement.

**12 JANUARY** A study in *The Lancet* (p 68), by two Spanish researchers reveals the first results of a trial to test a revolutionary new way to treat cancer with drugs. A. Brugarolas and M. Gosalvez used thiopropine to transform certain skin cancer cells back to normal, instead of killing them in the usual way. The drug acts on the cell membrane and does not affect normal cells. It is non-toxic over a wide range of doses. Of 32 patients treated, 14 showed signs of remission.

## THE NEW SCIENTIST

20 years ago

Medicine will become during the next ten years a more and more exact science. It would be a calamity for the social and economic structure of a country if the mean life-span were suddenly to increase from 65 to 85 years. Imagine the situation if the Minister for Health of a technically well-developed country were told by a reputable scientist that the life of every human being could be prolonged ten years by performing a delicate operation at the age of 20. In many ways this would be a much greater calamity than the explosion of a hydrogen bomb.

The New Scientist, 21 January, p 130

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# SCIENCE IN SAN FRANCISCO

Energy and the control of scientific hazards dominated the AAAS meeting in San Francisco. But lighter notes were struck by the song of the whale and the Amazing Randi

## Gloomy beginning

Pessimism is the word to describe the way in which this year's annual meeting of the American Association for the Advancement of Science began. The US is rapidly becoming a technologically second class country, is on the brink of a nuclear war, and has little chance of meeting its future energy needs unless some drastic action is taken very soon. These sentiments came not just from one speaker but from a wide spread of influential people who are leading figures in the US's science establishment.

The gloom set in at the start in Dr Simon Ramo's "keynote address"—the paper that begins the meeting. Ramo, the "R" in TRW and one of the company's co-founders, said that the US's "innovative and entrepreneurial spark is dying as in area after area our lead is closed by other nations". He finds this technological lethargy especially worrying because the US's economy and social structure are "rooted in generous availability of the fruits of technology."

The US is suffering from a number of problems, says Ramo. To begin with the country's industrial productivity no longer rises from year to year. On top of that the US now has a massive, and growing, balance of payments problem. And it isn't just oil that is causing this trade deficit: "we are now importing

manufactures at two and a half times the rate of oil."

Behind this picture of gloom is a decline in the US's R&D activity: "applied R&D in US industry... has not kept pace with inflation over the last decade". And much of the R&D that does go on concentrates on defence, and meeting the government's new environmental and safety standards.

Is there really any evidence for this decline? "Yes" says Ramo. Take, for example, the fall in the number of new technologically orientated companies being set up in the country. The US's top 100 industrial corporations may do most of the R&D in the country "but a loss of the contributions from innovative small entities is bound to be penalising."

The US government's policies have contributed greatly to this decline, says Ramo. "Our situation is not the result of a mysterious sudden decay of our basic innovative characteristics. It is rather to be found in inflation, high-tax policies, too low an investment rate and over regulation..."

Ramo's argument could be dismissed as special pleading by an industrialist seeking freedom from government interference were it not for the fact that similar criticisms of the US government came from the other side of the political

## Oil crisis reaches dramatic proportions

Because the US has done nothing but talk during the past decade, the country now faces the 1980s with the near certainty of a truly dramatic oil crisis during the decade. John O'Leary, who was Deputy Secretary at the US Department of Energy, views the new decade with "almost unmitigated gloom". He predicts that there will be at least one Middle East crisis in the 1980s—a forecast supported by several other speakers including Professor Dennis Meadows.

O'Leary says that the crises of the 1980s will be very different from those of the 1970s. At least in the past there was someone to step in and make up the shortfalls that came about when a particular oil supplier disappeared from the scene. Even the Iranian revolution didn't have too great an impact because within weeks "Iran's six million barrel a day loss was offset by increasing production from other OPEC nations of approximately four million barrels a day". Without this response, O'Leary said, "the relatively minor disruption of petroleum markets in the United States and Europe would have been converted to chaos." The future picture looks less encouraging. "For the past two or three years it has been evident that forces were at work that would at some point in the mid-to-late 1980s eliminate this strategic cushion of surplus-producing capacity." The cross-over "into a world of permanent shortages may already have occurred" O'Leary

added with a warning to all.

Dennis Meadows, whose book *The Limits to Growth* sparked off a round of gloom-mongering in the 1970s, also predicts a "traumatic interruption" of oil supplies over the next 10 years. Indeed, the general view of the symposium at the AAAS seemed to be that if there is another oil crisis in the near future



Barry Commoner

there would be military intervention on the part of the US to ensure its oil supplies.

Meadows was not alone when he forecast problems for the International Monetary System. Daniel Yergin's statement that between the end of 1978 and 1979 the US's bill for oil imports rose from \$800 million a week to \$1700 million underlined this fear.

Barry Commoner sees such figures as



Uphill road for US science?

spectrum. Barry Commoner also complained about the US government's failure to solve the nation's economic problems. And Commoner is now seen as being out on the left of American politics, with little good to say about the country's industry.

evidence that energy is "cannibalising" the US's economy. By taking an ever larger share of the gross national product, energy is draining more and more from the economy it is supposed to support. This, he says, is because 96 per cent of the nation's energy comes from non-renewable sources. And the cost of these will always rise exponentially as the energy industry has to exploit increasingly costly reserves.

The only answer, says Commoner, is to turn to renewable energy. And the renewable resource that could have the most immediate impact would be solar energy. The way that this could happen would be through alcohol production. Within just one or two years the US could eliminate its shortage of non-leaded petrol—the real cause of the queues at the petrol pumps in recent years, says Commoner—by adding alcohol produced from agricultural products to petrol to boost its octane level.

This alternative did not find unanimous support from the likes of Starr and O'Leary. The only point that was unanimously supported—apart from the agreement that the US is wasting time by conducting a never-ending energy debate without actually doing anything—was that the country should devote more attention to energy conservation. Chauncey Starr sees conservation as the only thing that will help the US stave off energy shortages in the coming decade.

For all their agreements on superficial issues, when it came down to what



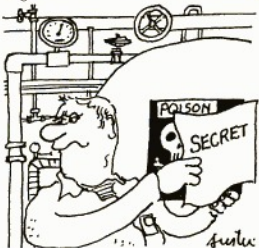
► should be done the energy experts at the AAAS symposium displayed as broad a divergence as you would see anywhere—which perhaps explains why, with so much contradictory advice coming from experts, the US government has found it impossible to arrive at an acceptable energy policy. Commoner wants to make the US totally "solar" by the end of the century. This would happen, for example, by changing the nation's agricultural pattern entirely, replacing soy bean production with growing sugar beet—such a strategy could substitute alcohol for petrol in the country's vehicles, and thereby expand the hopes of motorists. Chauncey Starr, on the other hand,

wants to keep open as many options as possible. And the way to do this, he says, is to fund as many energy technologies as possible to full-sized demonstration plants. Energy R&D has to go this far, Starr believes, if all the impacts of a new energy technology, including its environmental implications, are to be properly assessed. At heart, though, Starr is a believer in nuclear power: "It is here and the world must learn how to live with it". This does not mean that he rejects solar energy "It is not either/or" he insists, a viewpoint that now seems common to advocates of nuclear power, but which is in no way reciprocated by the proponents of solar power. □

trusion into a company's corporate privacy that would inevitably "destroy some of the competitive advantage of innovation".

Anthony Mazzochi of the Oil Chemical and Atomic Workers International Union was also concerned about corporate privacy—but of a slightly different kind. His union is campaigning to force chemical and oil companies to release information about the health of their employees and about the causes of their deaths. So far, the companies have refused to release what Mazzochi called the "litmus paper" revealing the motives of oil and chemical companies.

Mazzochi said OCAW is concentrating its campaign for the release of information on Colgate-Palmolive and Minnesota Mining. He predicted that the fight could well end up in the Supreme Court. He also predicted that Congress would, in response to industry's counter-offensive against regulation in general, water down TOSCA which he saw as merely a beginning—a "foot in the door" that the labour and environmental movement had gained only after many years campaigning. □



... too late?

## Getting to grips with chemical control . . .

The US's attempt to control toxic chemicals before they reach the workplace and the environment—the Toxic Substances Control Act (TOSCA)—is still the centre of fierce controversy, judging by the sparks flying at the AAAS session set aside to discuss the effect of the regulation of new chemicals on innovation in industry. Steve Jellinek, the assistant administrator of the Environmental Protection Agency (EPA) which enforces TOSCA, criticised companies that have submitted data on 51 new chemicals to the EPA in the first six months of TOSCA's operation because they have not given the agency enough information to enable it to decide about the safety of the products.

Many of the codes and regulations that EPA must draw up to implement TOSCA are still to be written. But the section of the act that forces manufacturers to notify the EPA of their intention to produce specific chemicals before they come on the market has been in force for six months. When notified of a new chemical, the EPA must decide if the new substance will pose an "unreasonable risk". If it so decides, it must act by asking for more information about the toxic properties of the chemical or by regulating its manufacture, transport or disposal.

As Jellinek pointed out, in a scheme of this kind the EPA will be hamstrung if manufacturers don't give the agency enough information. Yet that, according to Jellinek, is just what is happening. He said that the lack of information about the harmful effects of chemicals in the notifications the EPA has received so far was "most disturbing".

For example, none of the notifications so far received contains any information at all about the long-term effects of the 51 chemicals. Only 21 of the notifications contain any toxicological information at all. Only four notifications contain the results of short-term tests in bacteria (tests which give a strong indication of whether a chemical causes cancer or not). In very many cases, Jellinek said, the notifications contained no information about the number of people who might be exposed to the chemical. He promised that the EPA will bring into play the sections of TOSCA designed to force manufacturers to give information.

Not surprisingly, speakers from the chemical industry at the AAAS session

presented a rather different picture. Curtis Smith, from the Shell Chemical Company, repeated the chemical industry's plea that TOSCA "will have, at best, a significantly negative impact on innovation in the chemical industry". Citing the costs of the tests that EPA may force manufacturers to carry out to support their notifications of new chemicals, the cost of filling in the forms that TOSCA involves, the potential delays, and the fact that a product may be banned only after a company has spent many millions of dollars on it, he gave TOSCA a resounding thumbs down. He said that the act would reduce the rate of innovation in the chemical industry by a third.

Smith reserved some of his sharpest barbs for the way that the EPA intends to handle the perennial problem of confidentiality. Generally speaking, the agency intends to force manufacturers to substantiate any claims they make that information is a trade secret and so should be kept secret. The EPA also intends to reveal a chemical's identity once it enters production. Curtis thinks all this amounts to an insufferable in-

We are in real danger of sinking in a sea of cancer-causing chemicals, Professor Bruce Ames, of the University of California at Berkeley, told the AAAS. Ames believes that scientists have discovered so many cancer-causing chemicals in the environment that it is simply impossible to ban them all. On the other hand, he warned that we cannot simply sit back and wait for the delayed effects of many of these chemicals to become obvious as a rising toll of cancer.

Several recently discovered carcinogens were spotted by scientists using short-term tests, such as the one that Ames himself developed. These tests identify chemicals which damage the DNA of lowly bacterial cells and equate the ability to cause such damage with the ability to induce cancer—reflecting the dominant scientific view that cancer is the result of damage to the DNA of a cell or cells.

Ames noted one surprising trend in the mass of results from short-term tests that is now accumulating: that "industrial chemicals are probably not the major cause of cancer". Very little cancer, he suggested, "is due to the indus-

trial world", especially when compared with the large numbers of cancers produced by smoking, ultraviolet light and natural chemicals in food.

"There's no way we're going to ban all these carcinogens," Ames concluded. Instead, he suggested that scientists should develop methods of assessing the seriousness of the risk that a carcinogen poses, so as to set out priorities for regulatory action. Ames himself, for example, is now assessing how good a guide traditional animal experiments are to the potency of a cancer-causing chemical. Using a measure of potency based on the dose needed to give half the animals in a group cancer, he rates the most powerful carcinogens as a million-fold more potent than the weakest (such as saccharin). Extrapolating these calculations to man is complicated because, for one thing, the people exposed to a carcinogen are not homogeneous—laboratory rats are. Thus it matters little to black people that ultraviolet light causes skin cancer because they are practically immune. On the other hand, Europeans who move to tropical areas are especially susceptible. □

## More lessons from Three Mile Island

It was inevitable that the AAAS meeting could not survive without mentioning Three Mile Island and the Kemeny commission of inquiry into the accident there—and, sure enough, paper after paper had references to the disaster scattered liberally (and usually irrelevantly) throughout them. But one paper—from Stanley Gorinson, who was chief counsel to the Kemeny commission—really got to the heart of the matter.

Gorinson mounted a fierce sustained attack on the competence and political role of the Nuclear Regulatory Commission (NRC). His starting point was that the Kemeny commission's report marked a watershed. If the nuclear industry can change in line with Kemeny's recommendations, and if the government can learn how to regulate the nuclear industry, then nuclear power could be a "viable source of energy in this country." If not, the nuclear industry will become defunct.

The NRC, Gorinson said, was too concerned with promoting nuclear power to play a proper role in enforcing safety in the industry. He criticised the commission for its lack of reality. He quoted as an example of this fault the fact that the commission "had not realistically assessed the consequences of locating Three Mile Island in close proximity to a high population area". Thus, the NRC asked Metropolitan Edison, the company that operated the Three Mile Island Plant, to prepare an emergency plan that covered only the area within a two-mile radius of the plant—excluding Harrisburg, the big centre of population only 10 miles away. Yet during the accident, officials tried to draw up an emergency plan for zones within 10 and 20 mile radius of the plant. "Of course," Gorinson added, "it would have been wiser if the NRC, or the AEC (Atomic Energy Commission) had thought about these problems before licensing those plants. But that meant looking at the real world, rather than the fairy tale exercises that led plants to be sited at these locations."

Gorinson claimed that this lack of reality permeated the NRC's licensing procedures. The commission asked utilities to analyse only "single failure" accidents, ignoring the implications of the simultaneous failure of more than one system—precisely the kind of event that happened at Three Mile Island. The NRC's licensing procedures also demanded less thorough analysis of parts of the plant that it deemed to be "non-safety-related"—a distinction which Gorinson condemned as "arbitrary and artificial"—and excluded analysis of the interface between man and machine.

The NRC also ignored the advice of the Advisory Committee on Reactor Safety (ACRS), a statutory committee. Specifically, ACRS had questioned the failure of Metropolitan Edison to define the safety responsibilities of operators at the Three Mile Island plant. Metropolitan Edison's reply to ACRS's criticism was, Gorinson said, inadequate, yet the NRC thought it enough to "resolve" the issue. "The NRC staff," Gorinson complained, "undoubtedly came to this con-

clusion either because they believed that since nuclear plants are safe, accidents really can't happen so there was no need to know what safety functions the plant staff was supposed to undertake—an assumption that defies reality—or they never bothered to read Metropolitan Edison's response" to the ACRS.

Neither was the NRC's inspection and enforcement arm strong enough. Gorinson called it "lax, uneven and therefore ineffective". He criticised NRC inspectors for relying too readily on the utilities for data about the operating experience of nuclear plants and for supervising the actual construction of plants. All in all, Gorinson thinks the NRC behaved more like the Keystone Cops than a safety agency.

Clearly, Gorinson believes that many of these faults stemmed from the conflict between NRC's commitment to "nurture a growing industry" and its duty to make the industry safe. This conflict should have been removed by the reorganisation of the old Atomic Energy Commission in 1974, in which the regulatory and promotional functions were, theoretically, split and NRC was created. Obviously the reorganisation didn't work that well.

In another session at the AAAS, Joseph Coates, who runs his own company but

used to work in the government's Office of Technology Assessment, lent vivid support to Gorinson's thesis. He said: "The Atomic Energy Commission and its descendants have had the dual responsibility of regulation and advocacy. Being basically technologically orientated, the advocates shaped and framed the regulations to facilitate the development of atomic energy. They were not suitably mindful of the fact that it was an unusual technology. It did not evolve the way other technologies have—small scale, piecemeal, trial and error, feedback. It was developed in such a way that was almost the antithesis of every successful technology that we have in the United States. When you put advocates in charge of regulation, when you put blind optimists at the helm, you drive out reason, commonsense and prudence."

Gorinson warned that the reorganisation of the NRC suggested by the Kemeny commission must be real—radical surgery compared with the mere "shuffling of boxes" in 1974 when "the regulatory area of the AEC was simply renamed and continued along the same course". This radical surgery would, Gorinson said, include "the elimination of senior staff personnel who cannot or will not realise that their allegiance must be to safety regulation rather than 'nurturing a growing industry'."

## ... and the nuclear backlash

The nuclear industry was bound to begin to fight back against the wave of anti-nuclear sentiment that has swept the US since the Three Mile Island accident, but it is perhaps surprising that the backlash should begin before all the studies of the incident at the Pennsylvania power station have appeared. The US Nuclear Regulatory Commission (NRC)—the body responsible for nuclear licensing in the US—has not yet completed its review of the accident and its implications. However, in a hard-hitting paper, Edwin Zebroski, head of the recently formed Nuclear Safety Analysis Center (NSAC), attacked the "crypto-fanatics" who "piously observe that they are working to make reactors safer when their only real motivation is to shut them down".

Zebroski's centre, which was set up

under the auspices of the electricity utilities' Electric Power Research Institute in the wake of the TMI accident, has been responsible for some of the more detailed assessments of what actually happened at TMI.

While Zebroski's paper to the AAAS concentrated on non-technical issues, he did dismiss the notion that there could have been a China Syndrome accident at TMI which would have led to the reactor's fuel core melting and breaching the integrity of the containment vessel. According to him, the NSAC analysis of possible accident sequences shows that it would take "from many tens to hundreds of hours" after fuel started melting for there to be any threat to the containment. On the other hand, that does not mean that the reactor industry should ignore this possibility. In the past they have done so because the licensing process allowed them to forget about a meltdown—it wasn't covered in the regulations. Now they will almost certainly take the possibility more seriously, even if the NRC does not force them to.

The reactor came "uncomfortably close" to a core meltdown, according to Theodore Taylor, who was one of the members of the Kemeny commission which investigated the accident at the request of President Carter. No one knows how close they came, or how much longer the core could have avoided a meltdown with its emergency core cooling system turned off, said Taylor. We won't know what state the reactor core is in, or if any of its fuel did melt, until the people responsible for cleaning up the reactor can get in to look at the core. ▶



Russell W. Johnson

John G. Kemeny



► "My guess is that some of the fuel melted," was Taylor's assessment of what happened.

The response so far to the Kemeny report has been "encouraging", according to Taylor. Zebroski estimates that "some of the actions already put in motion reduce both the probabilities and likely consequences of future serious malfunctions of large equipment by a further substantial factor—perhaps three to five times already, and potentially by a factor of 10 or more within several years". If Zebroski is right in his estimates this suggests "a mean time between accidents with consequences similar to TMI as being 1500-2500 years of reactor operation . . . and potentially between 5000 and 10 000 reactor years after full implementation of the measures now under way". (Something like 500 reactor years were notched up prior to the TMI accident.)

The NRC is responsible for this tightening up in requirements and its representative at the AAAS session on nuclear reactor safety was Roger Mattson, who was the deputy to Harold Denton when he was in charge of the NRC's TMI team during the accident. Mattson admits that in the past the NRC has had some difficulty in learning from nuclear incidents and implementing changes as a result of them. This has not been the case following the TMI accident: the NRC has already added 24 new licensing requirements, and two-thirds of these were implemented by 1 January. The NRC's action plan, which also details the changes that the commission will have to make in its own operations, includes 245 specific changes. It could cost the nuclear industry \$4000 million, not counting the cost to the US government.

Just how reticent the NRC used to be in passing on the lessons of earlier nuclear incidents was spelled out by Ed Zebroski. The NRC, the utilities, and the reactor supplier were all in a position to avoid the accident at TMI because something similar had happened earlier. "Adequate analysis of prior and less-damaging events, but generally similar to the initial transient at TMI, was available in memoranda dating more than a year earlier, both in the reactor supplier, and in the NRC. Somehow these were not communicated to the utility." Reorganising the NRC to respond more quickly isn't the only answer, says Zebroski. The utilities must do something: their response has been to set up an Institute for Nuclear Power Operations as well as NSAC. Zebroski says "NSAC and INPO represent the first steps to assure national cumulative learning and improvement in respect to safety analysis and operating matters."

The US is not, of course, the only nation operating pressurised water reactors of the type built at TMI. Unfortunately, says Zebroski "many utilities overseas . . . tend to keep unpleasant events concealed so that the benefit of cumulative learning is lost". He went on to say "in this respect the confidence of some overseas agencies that they are immune from TMI-type events seem seriously misplaced", a sentiment shared by others. □

## Fearful findings

If governments want to encourage people to conserve energy, they may have to frighten them into doing it. Seymour Warkov, of the University of Connecticut, has come to this conclusion after investigating the reasons why a number of people did, or did not, decide to install solar heating systems on their houses in Connecticut.

Warkov found that the people who installed solar heaters were not swayed by the fact that they would save money, or insulate themselves against future rises in the price of fuel. What really convinced them was the fear that eventually the world will run out of oil, and they would not be able to buy the fuel they needed to heat their homes. Warkov discovered this by interviewing a number of people who had applied for grants to help pay for solar heating systems.

## Biotechnology and the scientific ethic

Lawrence McGinty

If the 1970s was the decade of concern and anxiety about the social implications of the application of the immense power of the physical sciences, then it is clear from many papers at the AAAS that the 1980s will see equally serious worries about the consequences of science's increasing ability to apply its knowledge of biology to social problems. And it is also plain that many of the issues that will be raised in the 1980s—of genetic engineering, test-tube babies and the ethical responsibilities of scientists studying the human embryo—strike at the very heart of the ethical norms dominant in society.

Take for example, one of the more "fanciful" possibilities raised by Clifford Grobstein, professor of biological sciences and public policy at the University of California at San Diego and the US's most eminent embryologist. A researcher takes a human egg from the womb. He fertilises it outside the mother—in vitro. He keeps the now-developing embryo in culture until the rudimentary beginnings of its gonads—ovaries or testes—are visible. He then takes an egg from the tissue culture and fertilises it with sperm derived in the same way, thus forming a new embryo. The whole life cycle is now complete: he has created a new individual from the previous generation, missing out entirely the adult stage of the life cycle. Impossible? Well, Grobstein clearly believed that this prospect is not imminent. But he equally obviously believes that it is not possible to dismiss it entirely.

In the immediate future, the most promising of the range of biological techniques for intervening in the development and formation of organisms is genetic engineering, Grobstein said. "Available techniques now make theoretically possible transfer of any nucleotide sequence (CNA) of higher organisms into bacteria. The sequences can be replicated along with the bacterial DNA and, under appropriate conditions, can also be transcribed and translated. In effect, bacteria can thus be genetically programmed to produce highly specific proteins." Grob-

In spring 1977 home owners in Connecticut were invited to apply for 750 \$400 grants for solar hot water systems. A large number of the 750 people originally approved to receive these grants did not take up the offers, so the North East Solar Energy Center commissioned a survey to find out why the people who did, and did not, go ahead with the solar installation made their decisions. Apart from being influenced by the suitability of their roofs for the equipment, the other key factor, according to Warkov, seemed to be "fear that some day the oil spigot will run dry."

Warkov believes that his findings are relevant to the energy conservation campaign. As well as appealing to people to conserve energy because it saves money and will make resources last longer, "an appeal based on fear may be required." □

stein thinks the prospects for genetic engineering are "very wide indeed"—even after dismissing the more fanciful scenarios. He sees "rapid advance in at least two directions". The first is that scientists will be able to use genetic engineering to study the mechanisms of genetics and embryonic development in humans. Their ability to inject pieces of human DNA into bacteria overcomes the scientific obstacles that have held up this research—namely, that human beings are too big and too slow to reproduce, as well as too complex, to study in the laboratory. Genetic engineering will change that, and so will create new opportunities for medical research—particularly in understanding why normal cells turn into cancer cells.

The second "spectacular" prospect Grobstein held out for genetic engineering is being able to manufacture useful chemicals and drugs far more efficiently than ever before. Genetic engineering is, he said, "a fantastic quantitative leap over older methods of obtaining desired pharmaceuticals by extraction or chemical synthesis".

One obvious potential, however, is that created by the birth (in England and India) of the first test-tube babies, embryos resulting from the fertilisation of an egg outside the mother's womb—in vitro fertilisation. These births Grobstein described as "among the most spectacular biomedical events of the 1970s". The reality of test-tube babies opens the door immediately to two developments that Grobstein thinks will create ethical problems. First there is the possibility of fertilising an egg in the laboratory with sperm that does not come from the husband of the woman from whom the egg was taken. Secondly, a fertilised egg need not be reimplanted into the woman who supplied it in the first place—"surrogate mothers" are clearly possible. Grobstein expects both of these developments to occur in the 1980s. But, he said, "neither seems likely to become frequent or to become accepted medical practice".

On the other hand, Grobstein does ►



AAAS

► expect "straight-forward in vitro fertilisation" to become "an accepted medical practice in many places at the end of the decade", although, personally, he puts it low on his list of medical priorities. And he warned that, although the technique is probably as safe for the mother as minor surgery, its safety for the child is less certain. Although eggs are "rather rugged" cells it is possible that they might be damaged when handled in the laboratory. The central nervous system might, Grobstein said, be particularly vulnerable and damage here might not express itself for many years.

More important to the ethical debate, however, are the possibilities that in vitro fertilisation creates for research and intervention. An egg that has been fertilised in the laboratory has to be observed to check that it is developing normally. Human eggs are basically the same as the eggs of other mammalian species, such as the mouse, which have also been kept alive in culture. But as embryologists can keep mouse eggs in culture for fairly long times, there seems no reason why human eggs could not be kept in culture for similarly long periods. This, as Grobstein said, "has opened a window, whether for observation or intervention, on previously inaccessible, very-early stages of human development".

Grobstein ended by calling for the establishment of a commission to discuss these issues. "We would do well," he said, "to establish some highly placed and widely respected place to discuss these subjects" and to help create "flexible and phased policies" to guide the implementation of biotechnology and the study of the human embryo. □

## Top of the cetacean pops

Michael Bright

Following spectrographic analysis of more than 600 whale songs, from populations around Bermuda and Hawaii, Roger and Katharine Payne, of the New York Zoological Society, can now identify from which area a particular whale was singing, and at what month of the year, simply by listening to the component parts of its song. Whale songs are built up from units (equivalent to musical notes) grouped into small repeating patterns called phrases, which in turn are grouped into phrases of the same kind, known as themes. Eight to 10 themes make a song, and the song is repeated without pause into a song pattern.

The whale breathes once per song, usually in the same place in the song, and without interrupting it, just as would an opera singer. Whale songs are much longer than those of, say, birds, with a complete song lasting 20-30 minutes, but their function, according to Peter Tyack, of Rockefeller University, is the same. Singing has, so far, been identified only in lone males which have been seen to pursue non-singing whales nearby. The whale's rendition is probably communicating information such as species, sex, age, location, identity, readiness to mate with females, and readiness

## Amazing

There can be few scientific meetings that have been graced by a professional magician doing his stuff before a packed audience. But that was the scene that greeted the eyes of the curious at the AAAS. There, the Amazing James Randi, the scourge of cheating paranormal performers, showed his tricks, including psychosurgery and paranormal photography, to a delighted crowd. People even pushed closer to the front of the large auditorium to get a better view—not a



Randi attacks the fakers

phenomenon common at scientific meetings. But Randi's lecture was not just entertainment.

He argued that the deception of those who pretend (even to themselves) to be able to perform paranormal feats is by no means wholly innocent. The seeds of the mass lunacy that led to the Jonestown "massacre" lie in every piece of paranormal fakery, he said. And most of the sick people who travel great distances to be treated by psychic surgeons return home uncured; some of them to die.

Randi did not support the call at last year's AAAS meeting from Professor John Wheeler to throw parapsychology researchers out of the AAAS. Instead he suggested that the AAAS demand evidence of the existence of paranormal phenomena from the researchers studying them and called for the AAAS to produce a "definitive statement" on the issue.

The biggest round of applause was reserved for the member of the audience who, supporting Randi's onslaught on fakery and self-deception, said: "we can be so open-minded that our brains fall out". □

## Space industrialisation

Space industrialisation offers far greater potential benefits to Third World countries than it does to the developed Western world, American researchers suggest. Peter Vajk of Science Applications Inc, California, presented a scheme for providing energy resources to India by means of solar power generating satellites (SPS) which beam down energy in the form of microwaves to a number of ground station collectors.

He said that SPSs have the potential to solve the energy needs of the millions of rural inhabitants of India, while also

providing many of them with much needed employment.

In the Third World, space industrialisation is a matter of life and death, said Vajk. Already communication satellites have provided a means of communication for doctors in rural areas. By contrast, communication satellites to a Westerner mean only the difference between watching a live TV broadcast from the other side of the Atlantic, or waiting a few hours for the film to be flown in—a small advantage in real terms.

Vajk suggests that 25 solar power generating satellites each producing 10 gigawatts of power could meet the entire energy needs of India. Electricity demand in India is small and concentrated in urban industrialised areas. But 80 per cent of the population live in some 600 000 rural villages. Their energy needs are for fuel for cooking and space heating. This is supplied at present by dried cow dung or firewood bought at costs far higher than US energy prices.

Distribution of electricity to these people would be impractical and probably undesirable as an immediate goal, Vajk maintains. Instead he pictures a methanol-based energy economy, with electricity directed from the 25 ground station receivers to around 400 methanol synthesis plants throughout the country. These plants could be built cheaply using local labour, with parts being manufactured in urban factories and then assembled on-site.

Methanol produced from air and water would be two or three times cheaper than fuels used today as well as being more efficient, says Vajk. A simple distribution system—carrying bottled methanol to the villages—would be feasible, he suggests. This distribution system could also become an important means of accelerating dissemination of news, education and other products once it has become established. □

to engage in antagonistic behaviour with other males.

There are distinct whale dialects. Whales in Hawaiian waters have different singing patterns from those off Bermuda. Whales from the same area, however, tend to sing the same song, and the song in each population is continually undergoing change. The changes are rapid, one component perhaps changing every two months. Taking a folk-song analogy, in the first month an individual might sing:

London's burning, London's burning  
Fire-fire, fire-fire . . . and so on,  
while two months later one phrase would be modified so the song becomes:  
London's burning, London's burning,  
London's burning  
Fire-fire, fire-fire . . . etc

What selective advantage a whale may gain from changing its song is unclear. Whether it's a dominant male trendsetter introducing the changes will be difficult to find out. The Paynes, in fact, are fast to point out that the new phenomenon they have demonstrated is far from understood. One thing, however, is clear, this work might, as a bonus, help to make sensible assessment of whale stocks. □

# The politics of American science

Scientists in the US complain about their government's tight control over the purse strings. But science in America is far from being unhealthy. It is, however, finding it difficult to come to terms with the passing of the days of continued expansion



The ill-fated B1 bomber, victim of President Carter's selective support

## Dan Greenberg

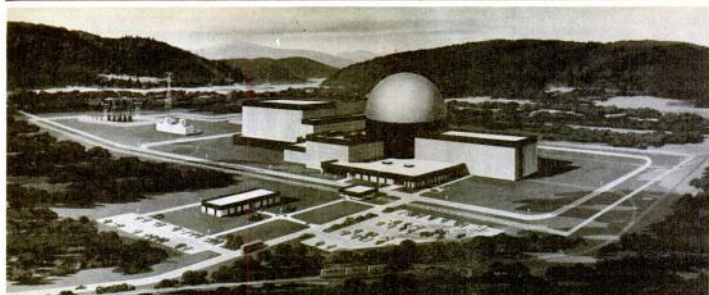
For the American scientific community, there have been worse times, far worse times, than the past three years of the Carter administration. But as it is *de rigueur* for our senior boffins to prophesy doom for the national scientific enterprise if this and that—usually more money and less accountability—are not instantly forthcoming from Washington, it is possible to get the impression that science here is *en route* to oblivion.

For example, the president of MIT, Jerome B. Wiesner, dourly proclaimed in November 1978 that the federal relationship with academic basic research "has begun to deteriorate and come apart so badly that we have reached a point of crisis that could see the effectiveness of the nation's major research universities seriously curtailed at a time when it sorely needs to be enhanced". And, just this past autumn, when American scientists once again dominated the Nobel prize awards for science, the director

of the National Science Foundation, Richard C. Atkinson, used the occasion to warn that it can't go on like this, the reason being, he explained, that other nations are surpassing the US in proportion of gross national product devoted to research and development.

Despite all this crepe hanging, the essential fact about research and development in the US is that it is a vast and well-financed enterprise, not lacking for pinches and problems here and there, but, overall, very strong right across the board. And, one of its greatest assets is that, following years of sourness in science and government relations under Lyndon Johnson and Richard Nixon, the Carter administration has developed congenial and constructive relationships with our institutions of science. In doing so, Mr Carter was carrying on with policies and practices that were initiated during the short-lived Ford administration, such as providing extra helpings of money to make up for the inflationary erosion of fundamental-





Artist's impression of the Clinch River nuclear plant. The complex was never built, as President Carter vetoed the plan

Nuclear Engineering International

research budgets. But once that historical tip-of-the-hat has been offered, the basic fact is that Mr Carter's administration has demonstrated an unusually attentive and cordial attitude towards science and technology; apart from the heroic go-go days of the space era, when even the most madcap scheme got a sympathetic hearing, the past three years have been our most productive and friction free in science and government relations for many years.

Furthermore, and this is important to register, the US Congress has accepted the fact that science and technology are properly a government responsibility, that they are very expensive, and that they require steadiness of support. The Proxmire factor notwithstanding, the Congress these days tends to be quite generous to research. Thus, the National Science Foundation—more or less our mammoth version of Britain's Science Research Council—is now at the billion-dollar-a-year mark; that's an increase of \$350 million in five years.

### Unjustified grouses?

Then what's the grouching about? Why, when the federal government spends over \$30 billion a year on research and development, and industry and other sources provide another \$20 billion, are there cries of deprivation? What's going on here when, as the National Science Foundation—official scorekeeper for R&D statistics—recently reported, "The United States spends more on R&D than the United Kingdom, France, West Germany, and Japan combined"?

The answer, of course, is that through most of the post-war period, many of our scientists and engineers became so accustomed to annual bursts of substantial growth that when the pace of expansion slowed and eventually brought the steady state that we're now in, the situation was viewed as catastrophic. For a university research department not to grow year after year—but to achieve a given size and just remain there—was considered *prima facie* evidence of disease in the science and government business.

What must be added to this is that, while Mr Carter is interested in and supportive of science and technology (he has several times singled out basic research for the rare privilege of "real" budgetary growth), he is fervently dedicated to pennypinching and budget balancing, and is sceptical toward technological monumentalism. It was Mr Carter who cancelled the B-1 bomber, the Clinch River breeder reactor plant, and who has consistently fended off congressional efforts to expand the space programme. The net effect, then, is that the president is pro-science and technology but is highly selective in manifesting his support. Let's look at some details:

**Defence.** R&D related to military purposes retains its sacrosanct place in US government priorities, accounting

for about half of all federal spending on R&D. This proportion, which has persisted through most of the post-war period, has been held by Mr Carter and Defense Secretary Harold Brown. Apart from grounding the B-1, the main policy shift in defence research Carter Style is in the direction of re-establishing the close links that existed between defence and academic pre-Vietnam. Hungry for money and now indifferent to ideology, the universities are keen for money from the Department of Defense—and though Congress has its doubts and refuses to give DOD all it seeks for this line of endeavour, there is little doubt that the Pentagon represents a major growth opportunity for American science. From DOD's perspective, the rationale is that the US should exploit its R&D advantage over the Soviet Union, and one way to this is to fire up the universities to turn out basic knowledge that can eventually be embodied in new weapon systems.

**Health.** The great research favourite of the American voter (opinion surveys usually find a yen for more money for health research), the medical sciences fared so well in the hands of their congressional guardians two years ago, that Mr Carter last year proposed a stand-still budget. Congress, of course, could not abide that, and, as a result, the budget for the National Institutes of Health—which supports most of our biomedical research—went over the \$3 billion mark. In terms of policy, the big shifts are away from the now-discredited "war on cancer" towards humbler and less flamboyant efforts to develop better understandings of cancer causes and preventions. Under prodding from Congress, the new fad in the biomedical realm is "nutrition", in which NIH now says it is investing over \$100 million a year. Meanwhile, NIH is carrying on with the great masterplanning exercise for research that was decreed by its cabinet boss Joe Califano Jr, before he was ousted from the Department of Health, Education and Welfare last summer. His successor, Patricia Harris, has approved the Califano design for devising "health research principles", and employing them to plan biomedical research in five-year chunks. So far, the system remains on tracks, but still to be seen is how Congress will react to a scheme that would reduce the legislative role in determining biomedical research priorities.

**Energy.** So many political cooks surround Washington's energy-research cauldron that it is difficult to assess what, in fact, is actually happening in the real world. An enormous amount of rhetorical courtesy is paid to solar energy, for example, and, it must be conceded, government spending for solar research has shot up rapidly. Nonetheless, Mr Carter's most recent operating budget for nuclear fission totalled \$796 million: the solar budget was about half that. The Carter plans called for crimping spending on solar demonstrations, on the theory that if solar energy



really works, the marketplace will swiftly adopt it. Congress, however, has closer experience with the value of federal subsidies for perking up the capitalist spirit of America, and has pushed hard for an expansion of government demonstrations of solar-energy systems. The interplay of political posturing and genuine dedication to promoting solar power is nicely symbolised by the appointment of solar apostle Denis Hayes as director of the government's Solar Energy Research Institute. Hayes, who is neither a scientist nor an engineer nor an experienced administrator, is, nonetheless, widely known and respected as Mr Solar Energy, in the US. It did seem likely, even to many who are sympathetic to solar energy, that Hayes could be better situated than as director of a big laboratory. In any case, the appointment is offered by the Carter administration as evidence of its commitment to solar energy. More money would be more convincing, but, as noted before, that comes hard for Mr Carter.

**Basic research.** Reflecting the consensus of the leadership of this country's loosely strung-together scientific-industrial complex, the Carter administration has emphasised support for basic research, because as Mr Carter said in a science policy message to congress, "Basic research... is the forerunner of new inventions, advances in health care..." and so on. The first two annual budgets of the administration, continuing the Ford policies, produced "real" growth of three to four per cent for the basic sciences. The current budget aimed for two per cent in real growth, but the intended effect was washed out by an inflation rate—nearly 14 per cent—that's about double what the budget-planners had anticipated. The net effect, then, is that basic research budgets are once again slipping down the inflationary slope. This is obviously bad for scientists, but whether it really has any harmful effects

on science is an altogether separate and different matter.

**Presidential science advice.** A subject of obsessive interest to the science-policy community and its congressional friends, science advice is seen by the White House as one of its lesser concerns. Mr Carter apparently has a good relationship with his science adviser, Dr Frank Press, former chairman of Earth and Planetary Sciences at MIT. But Press is not in the President's inner circle of advisers and is at most peripherally involved with the major economic and political issues that occupy most of the President's time. He is influential in the sense that his advice is sought and often followed on matters of science policy, including budgets, and the President looks to him for staff support and advice on such matters as the recommendations that the Three Mile Island Commission gave the White House. The Carter-Press relationship is as good as any in 20 or 30 years since the Science Advisory Post was established as a full-time job. But it should be viewed realistically for what it is, which is a relatively slender slice of the governing process in the US. Those who doubt this perception might consider the fate of the great industrial-innovation exercise—our latter-day "White hot technological revolution"—that Press helped put in motion. After a vast study, involving perhaps a thousand consultants, the ambitious proposals that our commerce department sent to the White House were shaved down to a mere \$55 million worth of cautious steps—all of which had been talked of for years.

Having long listened to the squeals that regularly come out of the scientific community, I suspect that the current production comes more from habit than pain. American science is, by and large, extremely well off, and its leaders realise this. They fear, however, that it might be bad politics to admit their good fortune. □

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# The New Scientist INTERVIEW

## Carl Sagan

Science populariser, star-gazer and  
intellectual gadfly  
talked with

Roger Bingham

**T**HE sign next to the elevator in the KCET Television station building on Sunset Boulevard, Los Angeles, reads: "Third floor—Cosmos". To the whimsically minded, it seems a spectacular feat of compression: 100 billion galaxies with 250 billion stars per galaxy; other worlds: perhaps other life forms. There is another name on the sign—also on the third floor: Dr Carl Sagan.

Of course, "Cosmos" in this instance is the name of the 13-part television series that Carl Sagan Productions, in association with KCET, is making for release to an estimated worldwide audience of 140 million later this year. And yet, there is something not entirely ridiculous in the notion that if the Cosmos were ever to be neatly reduced to exhibit-size, the prime mover might just install Sagan in an office next door as curator and guide to the visiting intelligentsia.

With a series of books (including *The Cosmic Connection*, *The Dragons of Eden*—which won him the 1978 Pulitzer prize for non-fiction—and, recently, *Broca's Brain*), and his regular television appearances (notably on the *Tonight* show), the 45-year-old Cornell astronomer has established himself as the great explainer. There is a temptation to say cosmic explainer, for the adjective routinely accompanies Sagan's name: Sagan the cosmic storyteller: Sagan the cosmic connector. A line from the poetry of his Cornell colleague Diane Ackerman seems to sum him up neatly: "Knee-deep in the cosmic overwhelm." This particular afternoon, Sagan is knee-deep in the Venusian clouds on set at KCET. He is standing at a telescope, eyeing a projection of the planet. Vertical beams on either side of him illuminate the billows of smoke-gun cloud. It's a tricky scene, involving a series of camera switches. Several takes are needed, punctuated by a brisk pep talk from executive producer Adrian Malone (who co-produced the Jacob Bronowski and J. Kenneth Galbraith blockbusters).

As usual, Sagan is casually dressed: tan trousers, corduroy jacket and a blue open-necked workshirt. He is a handsome man with heavily-browed penetrating eyes, deeply etched smile-lines and a mass of grey-flecked black hair. His face combines hauteur, sensuality and a winning boyishness—a pleasing amalgam of Rudolph Nureyev and George Plimpton. His vocal delivery is idiosyncratic to a degree: words he wants to emphasise take on a glutinous quality and seem to emerge with the greatest reluctance. As if they somehow adhere to his vocal apparatus. As Adrian Malone describes it, "Sagan f-o-o-r-r-m-m-s the w-o-o-r-r-d before you h-e-a-a-r it."

Despite the grace—even courtliness—of his gestures, you have the sense that Sagan is an intuitive performer rather than

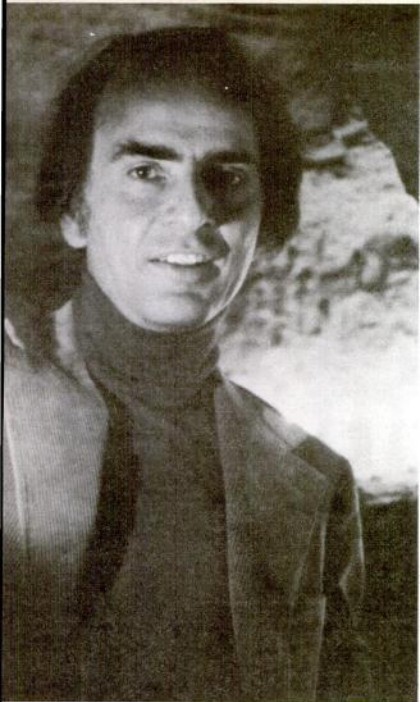


one who has schooled himself carefully. Certainly, the stresses of a production like this (particularly now that it is six months behind schedule) are considerable, and it is easy to understand some of Sagan's more obvious displacement activities—extravagant throat-clearing before takes, fussiness about the placing of the cue-card light, the way he "constantly delves into other people's jobs", as one of the team puts it. Sagan is a man who likes to be in control.

Eventually, the final take—viewed on the monitor—reveals a confident, amiable Sagan discussing Venus, offering explanations, injecting a little humour here and there. It makes good television. Malone is satisfied, the crew applauds, and Sagan beams disarmingly before retiring to his personal trailer (once occupied, so legend has it, by Marlon Brando).

Sagan's success as a teacher and communicator—and it is considerable—lies in his ability to infect an audience with a sense of his unbridled "thirst for wonder", as he put it in *Broca's Brain*, a thirst which has remained unsated since his childhood. "There is still a part of me that is 10 years old." He delights in talking to children and feels strongly that combined influence of parents and schools often makes a crime of naivety. "People are afraid of the questions of kids . . . How is it that kids in the first grade ask more penetrating scientific questions than kids in the 12th grade? Questions like why is the grass green or why is the sky blue? There are so many good answers, so why say: don't ask silly questions? Think of the cost. Think of the deprivation of future generations. You've just prevented the world from having another thinker . . . It's clear that there's





Bill Ray

not a society on the planet today which is working as cultures will need to work 100 years from now in order to be in existence then. How do we get from here to where we want to go? By challenging everything. That involves honing a habit of thought, which is precisely what those first-graders do naturally. It's what human beings are about. Yet society prevents them from seeking the answers that society most urgently needs. Well, that's suicidal."

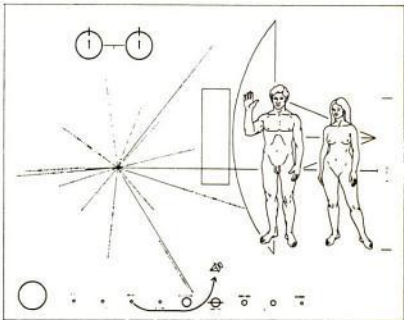
Sagan's championing of the naive, the irreverent and impertinent question speaks volumes about his own approach to problem-solving. He has always been willing to take an unconventional stand. His deductions about the high surface temperatures on Venus and wind-induced contrast changes on Mars (with his graduate student Jim Pollack) were later borne out and stand as good examples of his audacious theorising.

Naivety, he says, is "just what science is about, it means that you haven't bought the most recent answer fully. You're willing to tolerate ambiguity, while striving to remove it; that's necessary for survival."

With the death of Margaret Mead, Sagan has become perhaps the best known member of the group Rae Goodell has christened "The visible scientists"—articulate, opinionated public figures (like Barry Commoner, Linus Pauling, William Shockley, Paul Ehrlich) whose appearances and utterances often generate as much peer disapproval as public excitement. Scientists who communicate are still viewed with suspicion (and some jealousy) by their colleagues, and Carl Sagan could never be accused of maintaining a low profile.

He has often been portrayed as a scientific superstar, a charismatic figure with a vanity licence plate (Phobos—one of the moons of Mars) on his Porsche, a cavalier disregard for keeping appointments, and a whirlwind schedule that has turned him into a chronic workaholic. For many scientists, Carl Sagan has become a product marketed by Carl Sagan.

There is an element of truth in all of this: there is also a considerable amount of sour grapes. More importantly, it could be argued that Sagan is responsible in no small measure for the renewed public interest in science. Some of his exploits, undeniably, have been journalistic godsend. As a leading advocate and practitioner of the search for extraterrestrial life, he has attracted a cult-like following for a constituency that includes scientists and saucerians (whose ufologising he usually dismisses firmly). His promotion of the notorious plaque, depicting a nude man and woman, that was affixed to Pioneer 10, his ability to sell it to NASA and have it published in *Science*, was vintage Sagan.



Less risqué (the plaque was viewed in some quarters as the first smut in space) but equally ingenious was the interstellar record of sounds from the Earth (published as *Murmurs of Earth*) carried by the two Voyager spacecraft. Sagan's schemes can always be counted upon to be newsworthy. To have some serious intent (an exercise in what he likes to call "cosmic consciousness-raising"), and yet be carried off with great chutzpah.

It must be a considerable inconvenience to those who deplore Sagan's popularising that he has a distinguished academic background and almost 300 scientific papers to his credit. Such virtuosity makes criticism sound like ill-mannered carping. ("The quality of one's work is what matters," Sagan says. "It would be thought ludicrous to criticise someone's mathematics on the grounds, say, that he was an unpleasant dinner guest.")

Although on sabbatical this year, Sagan is David Duncan Professor of Astronomy and Space Sciences, Director of the Laboratory for Planetary Studies, and Associate Director of the Center for Radiophysics and Space Research at Cornell. He is the president of the planetology section of the American Geophysical Union; an interdisciplinary scientist on the Jet Propulsion Laboratory's project Galileo; the winner of two NASA medals (for "exceptional scientific achievement" and "distinguished public service"); winner of the Joseph Priestley award "for distinguished contributions to the welfare of mankind"; winner of . . . and so it goes on. And on: Prizes, medals, honorary degrees, chairmanships and memberships, lectureships, editorships (of the journal *Icarus*, for example), papers and popular articles are all set out in a closely typed 54 page vita supplied by his office. Whether such a document is outrageously immodest or merely a sensible and convenient record is a moot point. That Sagan has impressive credentials is incontestable.

Within the scientific community, Sagan is often referred to as an intellectual gadfly. Again, the connotation can be good or bad, but being bitten is always irritating—and being swatted is an occupational hazard of the gadfly. He provokes the fiercest blows when he steps outside his own discipline, which is happen-

ing with increasing frequency. According to Diane Ackerman, "Carl has a very nomadic mind. He's always picking up and pitching his mental tent somewhere else." ... Often on someone else's territory.

Despite lip-service to the contrary, scientists still operate a territorial imperative, and interdisciplinary trespass by intellectual Bedouins like Sagan is often frowned upon. The *Dragons of Eden*, for example (in which Sagan dealt with the evolution of human intelligence), won considerable public acclaim, but was less kindly received in the scientific press. Some critics saw it as little more than a clever piece of synthesising, which drew heavily on the work of other specialists and contained very little original thought (together with some unfortunate errors of fact). If you try and label Sagan—astronomer, exobiologist, planetologist—he demurs, insisting that the disciplines are merely tools. "I'm just somebody interested in how the Universe works," he will say.

Sagan was born in Brooklyn in 1934. The son of a Jewish father, who was a cutter—later a foreman—in the garment industry and who provided "a warm association with books" from a very early age. By the time he was 10, he had already read voraciously in astronomy (the stars fascinated him from the age of five, he recalls), decided that there must be life on other planets, and moved on to Edgar Rice Burroughs's Martian fantasies, the John Carter novels—in the hope of new inspiration. He remembers having an active and imaginative inner life during those childhood years, a memory confirmed recently by a cassette he met during the filming of a segment of *Cosmos* at his old elementary school. "Her perception was interesting," Sagan says. "She said: we called him the professor. He was always thinking about something else."

"I knew from a very early age that I wanted to be an astronomer—even before I knew the word. What I didn't know was that there was a profession. I didn't imagine you'd be paid for it, it was something I thought you'd have to do at weekends."

At 16, Sagan won a scholarship to the University of Chicago and found himself in the company of Titans: Enrico Fermi, Harold Urey, and Chandrasekhar. Even as a freshman, he attracted attention and was invited to spend a summer working at Indiana with Nobel Laureate H. J. Muller—an enviable way of learning about genetics. Back at Chicago, with a letter of introduction from Muller, he came into close contact with Urey and Miller at the time of their seminal "primitive atmosphere in a flask" experiments on the origin of life. Given the background, it comes as less of a surprise to discover that Sagan's first published paper—in 1957—was on "Radiation and the origin of the gene", published in *Evolution*.

With a master's degree in physics under his belt, Sagan moved on to graduate work in astronomy under the tutelage of Gerard Kuiper at Yerkes Observatory. During his time there, Sagan met the woman who was to become an important foil and mentor for him: Joshua Lederberg, then professor of genetics at the University of Wisconsin, a recently honoured Nobel laureate, and the inventor of the word exobiology, as chairman of the Space Science Board committee studying ways of searching for life in space, who asked Sagan to become a member in 1959. He was then 24. (There is a tendency to think of Sagan—because of the heavy media coverage in recent years—as a latecomer to exobiology. Nothing could be further from the truth.)

After spells at University of California at Berkeley and Stanford University (as visiting assistant professor of genetics—again at Lederberg's invitation), Sagan spent six years at Harvard and the Smithsonian Astrophysical Observatory, before moving to Cornell.

But however solid his academic career, it is inevitably the popularising which has attracted the most attention in



Bill Ray

**“I knew from a very early age that I wanted to be an astronomer . . . I didn't imagine you'd be paid for it . . . I thought you'd have to do it at weekends”**

scale is different by several orders of magnitude from the glib chatter of the *Tonight Show*. The information must be accurate, and yet there has to be a marriage of words and images. The right brain-left brain mix of television, the blending of intellect and intuition, is delicate and there have been times, according to Adrian Malone, when Sagan's cerebral powers seemed to act against artistic sensitivity. "He's a very literal man, you know—he likes to see the wounds in the hands before he believes—I think he's someone who focuses the laser on a certain area and devours it, focuses on another area and devours it. That makes—probably at the age of 95—an extremely well-balanced, educated, grand-tour human being. In the process, however, it makes for a lot of imbalances . . . in *Cosmos* he must delve more into philosophy and less and less into detail . . . and yet he likes the detail. I see a continual battle within him, which brings a kind of intellectual agoraphobia. You stand in the middle of this vast field and one part of you is crying out for some boundaries: another part of you is saying, you don't need boundaries: go further, go further."

Old friends such as Lester Grinspoon (professor of psychiatry at Harvard Medical School) have seen the same conflict within Sagan, though Grinspoon believes that Sagan has changed markedly in recent years: "I think Carl used to lead more with his intellect: now, he leads equally with his humanity. It's very impressive, the degree to which he's grown in this respect." Scientists are often uncomfortable with this kind of discussion of their characters, seeing it as irrelevant and intrusive. Their work, they argue, is all that counts. But the presenter of a series like *Cosmos*, which touches all facets of the human condition, arguably, is in a different position. Sagan has an appreciation of the fact that his audience is curious to know—as they say in California—where he is "coming from", but he remains a paradoxically private individual.

Under pressure, he finally relents and smiles and offers one observation: "I would be most happy if you would say that I'm deeply in love with Annie." (Annie Dryan, his fiancée, is a novelist, and one of the writers on *Cosmos*, and was creative director of the *Voyager* record. She has been his constant companion for the past 2½ years, and many people detect her influence in Sagan's personal growth. Sagan had two previous marriages.) According to his friend Grinspoon: "Carl is more and more comfortable with, more and more aware of human beings as other than carriers of cerebral cortices. And while he is in love with reason, I think he would agree with Pascal—the heart has its reasons which reason knows not whereof."

After *Cosmos*, Sagan is looking forward to a rest, and more involvement in full-time science. (He is particularly anxious to take a detailed look at the *Voyager* images.) More popularisation is on the cards, but he has no firm commitments at this point. One thing is certain: his restless intellect faces no shortage of challenges. As he puts it, "in a Universe with 10 to 20th-power planets, we're not going to run out of things to do."





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# Monitor

## Lady flies choose to mate with successful fathers

Jeremy Cherfas

An adult female fruit fly can endow her offspring with a competitive edge in the struggle to survive if she is allowed to choose her mate freely. This is the astounding conclusion of a series of painstaking experiments by Linda Partridge, of the Department of Zoology at the University of Edinburgh (*Nature*, vol 283, p 290).

The result is important for the effect it will have on theories of genetics and evolution. Two prominent theorists have argued that if a population of animals is genetically stable then it should not be possible for an animal to produce fitter offspring by choosing to mate with a fitter than average individual. Fitness here does not mean muscular prowess or stamina; rather it means reproductive success. Any gene that directly favours reproductive success will spread very quickly, so that in a stable population there will be little genetic variation between animals in their ability to produce fit offspring.

Partridge tested these ideas on the fruit-fly *Drosophila melanogaster*, favourite beast of geneticists. She kept the flies in a large so-called population cage, which contained many thousands of animals. Each female had a practically unlimited choice of males with which to mate. From this cage, Partridge took 100 females that had been inseminated by the male of their choice, 100 males, and 100 virgin females. She put each female



Bruce Coleman

in a vial—virgin females with a male—and let them get on with the business of reproduction. Once the eggs had hatched she collected the larvae from the “choice” and “no choice” mothers.

Partridge then pitted batches of 200 of these “choice” or “no choice” larvae against a standard opponent in a test of their ability to survive to adulthood. The opponent was 200 larvae of flies that carried the gene *sparkling*, a mutant gene that makes the eyes of a fly carrying it very shiny and easy to tell from the normal, wild-type fly.

The competitive arena was a vial that contained a little food, but not enough for all 400 larvae; only the winners would make it to adulthood. When the larvae had become adult flies, Partridge counted

how many of the adults were normal wild types and how many had shiny eyes, to see how the experimental larvae had fared in the competition. There was a small, but highly significant, difference in favour of wild-type flies in the offspring from females that had mated freely. In other words, fewer larvae from a female who was given a mate survived to adulthood, compared with larvae from a female who chose her own mate.

Survival to adulthood is just one component of reproductive success, and Partridge is at pains to point out that her results do not show that mate choice affects overall reproductive success; some other component of fitness may be decreased by mate choice. But to affect even one component of survival by allowing the female to choose is important.

Partridge speculates about the various mechanisms that might underlie her results. It could be that, contrary to orthodox theory, fitness can be inherited directly. If this is so, fitter flies might be better at getting access to mates, or flies may be able to detect fitter mates and select them. Either way, all flies would prefer the same type of mate. Alternatively, flies with great genetic diversity might be fitter. In this event, females could improve the fitness of their offspring by choosing to mate with a male genetically unlike themselves. If this were so, different flies would prefer different types of mate. □

## Gravity lens theory gains weight

Nigel Henbest

Astronomers at the Hale Observatories have found further evidence that an apparently double quasar is actually two images of the same object, split by the gravitational effect of a nearer galaxy.

The “double quasar”, catalogued 0957+561 (its position on the sky), burst into the news in May 1979. Radio astronomers at Jodrell Bank had earlier identified this close pair of star-like objects as a celestial radio source, but only when Dennis Walsh, Robert Carswell and Ray Weymann examined their optical spectra with the 2.1-metre telescope at the Kitt Peak National Observatory, Arizona and the 2.5-metre telescope, at the Stewart Observatory, also on Kitt Peak, did its remarkable nature show up.

Spectral lines of a quasar (or quasars) are systematically shifted to longer wavelengths—“red shifted”—according to their distances. It would have been an improbable coincidence if two quasars at different distances had chanced to lie so close together in the sky (they are just 6 seconds of arc or 1/300 the apparent diameter of the full Moon apart). But the red shifts of the two quasars are exactly the same; and even stranger, their spectra are identical. This made Walsh, Carswell and Weymann suspect that they were in fact looking at two images of the same quasar.

Gravitational fields can deflect light

(and other radiation); and a more distant object is focused into two separate images by the gravitational effect of a nearer body along the line of sight (*New Scientist*, 20/27 December, p 928). Walsh and his colleagues suggested that a nearby galaxy is responsible for splitting the quasar image in two. Although it would be nearer than the quasar, the galaxy would be intrinsically less luminous, and so might be too dim to be seen. If the gravitational lens interpretation is correct, the galaxy should appear to lie between the two images of the quasar.

Radio astronomers found that the northern of the two “quasars” is a radio source flanked east and west by other sources (a common configuration for quasars and radio galaxies), while the southern is a single source.

Researchers using the Very Large Array (of 27 separate radiotelescopes placed along the arms of a Y) at Socorro, New Mexico, thought that this structure was difficult to reconcile with the effect of a gravitational lens, and concluded that 0957+561 is in fact a pair of quasars orbiting each other in close proximity (*New Scientist*, vol 83, p 803); a team of radio astronomers from Cambridge and Jodrell Bank on the other hand said that the similar radio brightness of the central northern source and

the southern single source supports the gravitational lens hypothesis—but that these observations alone couldn't decide the issue (*Nature*, vol 280, p 461).

Now Jim Gunn, Jerome Kristian, Beverly Oke, J. A. Westphal and Peter Young have swung the balance firmly in favour of the gravitational explanation. Observing the quasar “pair” with a sensitive electronic light detector on the Hale Observatories' 5-metre (200-inch) telescope, they have found the image of a galaxy lying between the two quasar images—as predicted on the gravitational lens hypothesis, but an almost impossible coincidence otherwise. This galaxy is the brightest of a populous cluster of galaxies. Although the galaxy itself is too faint and lies too close to the southern quasar image for its red shift to be measured directly, the spectrum of the southern quasar shows signs of being absorbed by intervening matter, lying at one-third the quasar's distance from us. This is so similar to the galaxy's distance, as estimated from its apparent brightness, that the quasar light is undoubtedly passing through the intervening galaxy—and so a gravitational lens effect should be occurring.

Knowing now where the galaxy lies with respect to the images it is producing, Gunn and his colleagues predict that the southern image may itself comprise a very close double image, and they are urging astronomers, both optical and radio, to make a detailed examination. □



## Chemical editor trims the genetic code

A group of biologists at Yale University has just arrived at what may prove to be a major insight into the workings of animal cells. The manufacture of proteins and its control in simple cells such as bacteria has been quite well understood for some time. But more complex cells such as those that make up many-celled animals have presented a much more complex problem that the ingenuity of biologists has so far been unable to solve. The main difference between bacterial and higher cells is that the latter possess a nucleus that encloses the DNA containing the genetic code.

An important clue to the reason came with the startling discovery two years

ago that the genes of higher cells, instead of reading straight through the DNA like those of bacteria, were interrupted by stretches of DNA that did not code for proteins. This meant that before the genetic message escaped from the nucleus to be decoded into protein, the interruptions must be removed from it. It is the mechanism by which this editing takes place that the Yale team thinks it has discovered (*Nature*, vol 283, p 220).

The "discovery", however, involved virtually no actual new data. In fact, finding the answers to the many questions raised by the discovery of "split" genes may well prove to be less a question of gathering new facts than of recognising

the significance of old ones. For example, one of the first questions biologists asked was whether the non-coding interruptions in the gene were removed before or after the DNA had been transcribed into RNA.

They found the answer (which is yes) in a well-known but ill-understood entity known as "heterogeneous nuclear RNA"—called heterogeneous because it was much too long to code for any single protein. Once they were in a position to look at it more closely, biologists discovered that the extra length was accounted for by the non-coding parts of the interrupted gene.

To this lengthy RNA, which they still refer to as "hnRNA", Michael Lerner and his colleagues at Yale have found attached another ill-understood nuclear entity known as ribonucleoprotein, or RNP. And they have very strong reasons for believing that the ribonucleoproteins attach themselves to the RNA to remove the non-coding sequences of the DNA.

Ribonucleoproteins are made of a mixture of seven small proteins and short strands of RNA. The sequences of the nucleotide subunits of the RNA are known—and the important insight at which the Yale biologists arrived was that these sequences matched the nucleotide sequences at the junctions between the coding and the non-coding parts of the hnRNA. The junction sequences are so far the only parts of the non-coding sequences in which biologists have been able to discern any pattern at all; and what they have found is that although they are not identical in all cases, there are very strong similarities in most. This led them to believe that the junction sequences must act as a recognition signal for the enzyme that splices out the interruptions in the gene. What better recognition mechanism than a fragment of RNA with a matching (or, strictly speaking, complementary) sequence? In fact, the RNP RNA contains, side-by-side, sequences complementary to those at the two ends of the non-coding sequences. One idea as to how the process works—as yet unconfirmed—is that the RNP RNA sticks on to the ends of the non-coding sequences. It would then draw the ends together, looping out the non-coding region.

There is other suggestive and circumstantial evidence for such a key role for RNP. First, it has hardly changed in the course of evolution from insect to man—which is to be expected of a molecule with a vital function common to all cells. Second, it is more abundant in cells which are very active in making proteins. And finally, if the sequences that are complementary to the junction sequences are removed from the RNA, the RNP particles no longer stick to the hnRNA.

Lerner and his colleagues now plan to extend their investigations to a wider range of RNPs, and to hnRNAs from known genes; and to test the effect on splicing of antibodies against selected RNP molecules. They hope to confirm what is so far only speculation.

## A tide in volcanic affairs

When La Soufrière erupted on St Vincent Island in the Caribbean last April, forcing the evacuation of 20 000 of the 110 000 islanders, it was only behaving true to its nature. As in the past, the volcano exploded in phase with the cycle of Earth tides, Frederick J. Mauk of the University of Michigan, Ann Arbor, told the American Geophysical Union meeting in San Francisco last month.

In 1972, Mauk and M. J. S. Johnston reported a marked correlation between Earth tides and most known volcanic eruptions since 1900. Earth tides, which are slight deformations (up to 10 centimetres) of the Earth's crust caused by the gravitational pull of the Sun and Moon, have cycles of 12 and 24 hours and about 14 days. Obviously, volcanoes do not explode every time a tide occurs. Mauk speculates that the tides provide the "final bit of stress" necessary to release the fury of an already primed volcano. The response of a volcano may vary with its location and type, but most seem to favour the maximum of the fortnightly tide, he says.

La Soufrière, Mauk found, is particularly well behaved. It appears to have two dominant times of activity: at the

time of the maximum amplitude of the fortnightly tide and five days after the maximum. And, upon checking the times of the eight explosions that occurred during 12 to 22 April, he found La Soufrière was acting predictably. Eighty per cent of the explosions in that series began within one day of the fortnightly tidal maximum. The probability of such a high correlation occurring simply by chance is less than 0.01 per cent, he says.

But unlike most other volcanoes, La Soufrière allowed a closer look at other tide-related behaviour. Because the times of the volcano's explosions had been so accurately recorded by ground-based and satellite observations, Mauk was able to compare them with the times of the diurnal and semi-diurnal tides. These observations clued him to La Soufrière's response to the direction of acceleration of the tides. He found that 70 per cent of the explosions occurred when the direction of acceleration of the semi-diurnal tide was upward. Apparently, he says, the volcano is sensitive to both the direction and amplitude of the tides. The probability that La Soufrière's explosions are tide-triggered is "better than 99.5 per cent", he says.



During the 1971 eruption on La Soufrière a lava plug (right) formed in the lake

# Monitor

continued

## Electrons get to the heart of the matter

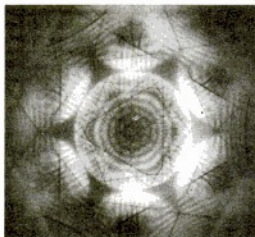
Rob Herman

The intricate pattern on the right has been woven not by an artist's hand but by nature herself. Its regions of light and shade reflect the regular pattern of atoms in a silicon crystal. This particular pattern was made not by natural light, nor by its short wavelength equivalent, the X-ray. The illumination was a sharply focused beam of electrons moving at over half the speed of light. The micrograph was taken in an electron microscope using a little-used technique called convergent beam microscopy (CBM). Electron microscopists at Bristol University are now developing and applying the technique.

Besides being very elegant, CBM images have a practical application. They provide a key to the crystal structures of a material, and thus a crucial guide to its physical properties. They can help in identifying structures from much smaller regions than the more conventional method of X-ray crystallography. And they can distinguish between different structures that occur in small patches, which is vital in one of their major applications—characterising the difference between successful and unsuccessful contacts to semiconductor devices. Another use is in testing for changes that could affect the properties of steel. Bristol University scientists have collaborated with the nearby laboratories of the Central Electricity Generating Board at Berkeley, in

Gloucestershire, on a study of a stainless steel that could be used extensively in a British fast breeder nuclear reactor.

The basic idea is a simple one. A conventional transmission electron microscope uses a beam of electrons accelerated by an electric field and focused by magnets on to a sample. Usually a fairly wide beam falls straight on to the sample: the image is formed by the electrons that pass through. There are a few variations on this theme, but all use an essentially parallel electron beam. It was in the late 1960s that microscopists developed the scanning transmission electron microscope (STEM).



Zone axis pattern for a single silicon crystal

Here the beam is focused on to small regions of the sample and the whole scanned point by point. CBM uses the same beam configuration (thus the name convergent beam)—but it looks for very different information.

Instead of focusing the electrons that pass through to form an image, CBM forms a "diffraction pattern" of the specimen—an array of spots that indicate the directions the electrons are scattered into. Microscopists make sure they get their information in the simplest and most useful form by carefully positioning the sample so that they look down on an axis of symmetry. They chose a direction called the zone axis—thus the general name for such patterns, zone axis patterns or ZAPs for short.

The ZAP made by CBM contains an array of discs with brightness changes that reflect the variations of the transmission of electrons at different angles in the crystal. Further out in the pattern are bright rings—the diameter of the innermost of these bright rings is directly related to the spacing between equivalent planes perpendicular to the axis of observation.

Although this is probably not the best way of measuring this spacing in a simple case where the structure of a sample is well known, it can be an extremely simple way of distinguishing between several possible structures. One example is a group of materials whose atoms are arranged in layers (rather like graphite). Sometimes successive layers are exactly the same and stacked with identical positions directly above each other. The structure may repeat after a small number of layers—two, three or sometimes more. The diameter of the inner ring indicates the repeat distance for identical layers. K. K. Fung, one of the Bristol microscopists, has become a world authority on the subject—so much so that the famous Bell Laboratories in New Jersey is among the many establishments that have sent him samples for analysis.

Another part of the picture consists of the lines of light and shade that seem to cross it in regular patterns. Using simple geometry, microscopists can usually relate each dark line crossing the central bright spot to the bright lines in the first dark region and hence to the plane in the crystal that gave rise to it. But for ZAPs with too many lines this method becomes too complicated, and microscopists must resort to computer simulation methods.

These lines shift with any change in lattice parameters—the distances that separate equivalent atoms in the material under analysis. Although here again it is difficult to make absolute measurements, it is easy to measure changes—resulting from a change in temperature or composition, say—with a known standard. Scientists may be able to use this aspect of CBM to investigate a phenomenon that has puzzled them. Changes in external conditions, such as temperature and pressure, cause changes in the

## Father feeling affects vole mothers

The pheromones of behaviour, those intriguing hormones that affect through smell, were discovered largely as a result of experimental work done on rodents. It is among the rodents that many of the more interesting pheromone-mediated behaviour patterns occur. One of these, discovered by Hilda Bruce and now known as the Bruce effect, involves the abrupt termination of pregnancy in a newly-mated animal when she is exposed to the smell or presence of a new "strange" male, but not when she is re-exposed to her original mate. While ardent sociobiologists could spend many a happy hour pondering the evolutionary advantages of this to the new male and his genes, we still know surprisingly little about the mechanics of this phenomenon. S. R. Milligan of the Department of Physiology at Kings College, London, has recently filled in a few of the gaps with a rather macabre experiment. (*Journal of Reproduction and Fertility*, vol 57, p 223.)

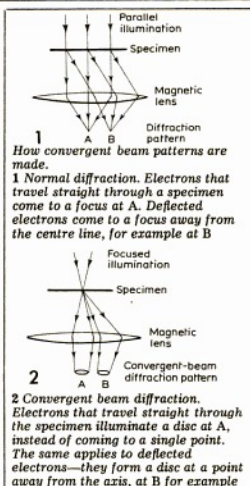
Working with the vole (*Microtus agrestis*) Milligan set out to ascertain how long the female needed to be with the male to distinguish him from the strange male at a subsequent meeting. He set up a group of virgin females and allowed them a period of "interaction" with a lusty adult male. The females were then removed and two days later

either re-united with their lost love or introduced to a strange male. After only an hour's initial contact, the Bruce effect still held good. Over half the females given a new male abandoned their pregnancy at once ready to oblige the new male, whereas most of those reunited with their first mate held on to his progeny.

So, if it is the "strangeness" of the new male which blocks the pregnancy, what would happen in the seemingly impossible situation of a newly pregnant animal meeting a male for the first time. The almost impossible was achieved by making the animal pseudo-pregnant with the aid of a pituitary sex-hormone and, to quote, "stimulation of the vagina and cervix with a motor-driven rod". Two days after this mechanical mating, the females were exposed to the real thing. Nearly 90 per cent of them terminated the pseudo-pregnancy to take advantage of the new male.

So, it looks then as if any male has the ability to block a new pregnancy when he arrives on the scene, unless the female remembers him to be the father of her young, in which case she holds onto them. To do this, she needs to be with the male only for an hour, or possibly even less, for her memory of the father to be established. □





► crystal structure. Sometimes the effect is to change the size of the repeat unit—instead of repeating every two atoms in a particular direction, say, the pattern may repeat every six atoms.

One way that this could happen would be for each series of three groups of two atoms to acquire a pattern of internal movements—a distortion of the original structure. But recently physicists have found that in some cases the repeat lengths of the patterns of distortion bear no simple arithmetical relation to the original ones. This observation has fascinated theoreticians, and they hope that by watching the transition under CBM they may be able to explain the phenomenon. Theoreticians believe they can explain the effect by what they call "charge density waves" that permeate the structure.

These theoretical matters are essential to interpreting ZAPs, but the Bristol microscopists also have firmly in mind the practical applications of CBM. One of these is to look at an important technical problem facing the growing British electronics industry. A major reason for scrapping a chip or other semiconductor device is mechanical or electrical failure of the metal contact which carries the signal into and out of the device. The Bristol group has studied a wide variety of metal joints to semiconductor devices based on silicon or gallium arsenide.

By looking at the microstructure at numerous points along the joint researchers can identify a number of characteristic features. Members of the Bristol team have now done this so often

that they can pick out those related to the performance of the contact. And they can now guide makers in improving their fabrication techniques. The Bristol team advises, among others, the Gallium Arsenide Consortium, a UK group that includes the Post Office, the Royal Signals and Radar Establishment at Malvern, the Plessey company and the Standard Telephone and Cable's.

It's not always so easy to relate the information CBM can provide to a technological application; even thorough research can leave important question marks. This is true of studies that the Bristol group has made on 316 stainless steel. The Central Electricity Generating Board wants all the information it can get on this steel, because it plans to make extensive use of it in Britain's proposed fast breeder reactors.

The steel has already been widely used in plant that has to meet stringent design criteria but different batches continue to show a wide variation of physical properties, especially in their response to long periods of use or simulated ageing. A wide range of tests by Bristol and CEBG researchers identified changes in mechanical and microstructural properties. But by the time when the Bristol group's involvement in the collaboration ended (as students got their PhDs) the team had not succeeded in relating the two types of changes—in fact the researchers couldn't even say confidence whether the differences in microstructure were due to changes in the manufacturing process between batches or had taken place during the steel's working life.

Investigation of the link between microstructure and bulk physical properties is a research area Bristol would dearly like to pursue. The Science Research Council has allocated to the Bristol group three places in its Cooperative Awards in Science and Engineering (CASE) scheme for such work on steel, catalysts and semiconductors. But none of these awards—which are not generally popular among graduating students—has been taken up.

The joint approach involving both an industrial laboratory (in this case, the

CEGB) and a university group is extremely valuable, as the CEBG labs can't spare the research effort to look into general topics: its researchers must work on specific materials. Fortunately a study of the more general aspects will continue—one of the Bristol group is going to Oxford University as a post-doctoral researcher to take a more general look at links between microstructure and bulk physical properties with scientists at the UKAEA establishment at Harwell.

Without the research effort of one UK company, Bristol might never have taken up CBM. John Steeds, who now heads the electron microscopy department at Bristol, first got interested in zone axis patterns when working with equipment bought with a grant from ICI's laboratories at Runcorn: he wanted to use them to study catalysts. But two practical problems prevented it fulfilling its promise until some years later.

The first problem was to make a lens that would focus the electron beam so that it would converge onto the specimen. This is not in itself difficult, but such lenses were of no use to the normal transmission electron microscopist, and so were not made. When scanning transmission electron microscopes came along in the 1960s, they needed the same sort of lenses, and so these became widely available.

The second problem was more serious: contamination in the microscope tends to accumulate on the part of the sample irradiated by the electron beam. If the illuminated area is decreased (as in CBM) the density of contamination rises accordingly. As a result early attempts to use the method were too blurred to be of much use.

But one group in Australia had persevered, and in the early 1970s began to report good progress. Steeds set one of his students at Bristol, Geoffrey Rackham, to see if he could improve the quality of the results. Rackham took up the idea with enthusiasm. His painstaking efforts to remove all sources of contamination from inside the microscope are described with admiration by his colleagues. Rackham was eventually rewarded by images like the one above. □

## Humans don't use animal tip-off system for birth

When an animal fetus is ready to be born it sends a chemical message to its mother to begin to give birth. This applies to many domestic animals—but not, it now seems from some Hungarian research, to humans (*Hormone Research*, vol 11, p 213).

Physiologists discovered the chemical tip-off system while investigating some rather odd happenings among pregnant ewes. Lamb fetuses whose brains had failed to develop properly after their mothers had eaten toxic plants weren't born after the usual gestation period. Further research threw up a new idea—that the fetal brain played a vital part in the onset of parturition. Birth seemed to be triggered by surge of corticosteroids, animal steroids made in the

adrenal glands from cholesterol. The surge is triggered by the pituitary gland in the brain.

Does the same apply to human birth? To answer this I. Vermes, I. Kajtar and E. Szabo of the City Hospital and Medical School, Szeged, sampled blood from the umbilical cord, from the mother, and from the fetal amnion, its fluid filled protective capsule. They found that the steroid hormone levels did rise in both fetus and mother in parturition. However, parallel studies of birth by Caesarian section showed that it was the stress of delivery itself which caused this rise and not that the onset of parturition was triggered by it. We still don't yet know what, in humans, triggers its onset at just the right time. □

# Technology

## Computers that learn could lead to disaster

A computer in Australia which has written its own software could herald the day when programmers—people who feed computers with instructions—are no longer needed. Not only has the Australian machine taught itself to solve a particular problem in chess, it has written its own program of instructions which is about five times more efficient than the best program the computer's "master" could come up with. The development has reinforced fears that computers could be handed responsibility over vital areas of decision-making without humans becoming involved.

Ross Quinlan of the Basser Department of Computer Science at the University of Sydney developed the system called ID3 which is capable of "automatic programming".

Quinlan's ID3, which is itself a program that uses techniques developed in artificial intelligence (AI) research, cuts out the need for a programmer. In its first success, the computer was presented with examples of different positions on a chessboard. The computer is told in each case that the game will either end in three moves, or alternatively, that it will not.

From these examples, ID3 identified about 50 key "properties", such as the distance between knight and king, and related them to a set of logical rules which determine whether a particular position will end in three moves. ID3 automatically translates these rules into a programming language called LISP.

The best program in LISP written by Quinlan took 17.5 milliseconds to produce results on a large Control Data Cyber machine in Sydney; but the ID3-written program took only 3.4 milliseconds. Quinlan is likely to give the first major public demonstration of ID3 at a conference in London in April.

Although this application of ID3 concerns chess problems, like much pioneering AI research, it could have tremendous implications for the wider use of computers. One of the biggest bottlenecks and costs in developing computers is in programming. Much work on automatic programming is undertaken by computer manufacturers.

For example, IBM, the biggest computer manufacturer, has worked on an automatic programming system for businessmen. IBM has produced a language, called Query-By-Example, which simplifies the process of removing information from a computerised database without needing, as often happens, a new program.

Although ID3 represents an important advance in AI, one of the most fervent advocates of AI, Professor Donald Michie of the Machine Intelligence Unit at Edinburgh University, this week warned that such systems could lead society into a "technological black hole" in which humans will not be able to understand the reasoning behind computer results that make key decisions.

Speaking at the Institution of Electrical Engineers in London, Professor Michie said that a "human window" should be built into all computer systems. This should let people question a computer on why it reached a conclusion. Automatic programming could further deepen the black hole—unless there was an explicit requirement that the computer-produced program was intelligible to humans.

Talking to *New Scientist* before his speech, Michie cited two examples of the consequences of the lack of a human window. In the Three Mile Island nuclear incident, great confusion and delays were caused by people's inability to understand quickly the meaning of computer-controlled alarm signals. And

recently a military computer falsely caused an alert, based on false data, that Russian missiles were heading for the US. In this case, Michie asked, how could the US President question the reliability of the computer?

Michie believes that one avenue of human salvation lies in the development of "expert systems", which are programmed in the strategy of human reasoning rather than merely as number-crunchers or information-sifters as in current computer programs (*New Scientist*, vol 84, p 178).

Because expert systems resemble human, rather than computer thought processes, they could help to provide humans with a way of staying in command. □

## Sailors keep a weather eye open

Ten of the 110 sailors due to take part in the *Observer* Single-handed Transatlantic race in June will effortlessly help French and British weather forecasters to predict the conditions in the Atlantic. Every boat in the race will carry special transmitters to tell the race organisers, through a satellite link, its position up to six times per day. In addition, the transmitters on the selected 10 boats will automatically transmit temperature and pressure readings.

This is the first use of satellites to plot positions of yachts in a British-organised race. The plan has created controversy within the racing community. Some sailors like Chay Blyth are in favour of the system; others like Richard Elliott believe that the transmitter will be equivalent to a "spy" which will let the organisers learn, and possibly give away, the tactics of individual yachtsmen.

Others believe that the system has serious limitations. For instance, the equipment will not be able to tell race organisers whether, if it stops transmitting, the yacht carrying it has sunk, or whether the unit has merely stopped working. The organisers reply that they will be able to direct rescuers to a precise position within a few hours of the unit stopping transmissions.

Each transmitter will relay signals to

two satellites in polar orbits, the French Tiro-N satellite and the American NOAA-A. The satellites will relay the signals to the French national space agency in Toulouse. From here they will be transmitted directly to Plymouth, where the race headquarters are. Weather information will go to the French meteorological office and its British equivalent within three hours at the most.

In addition to providing greater safety for the yachtsmen and women taking part, the main benefit of the tracking system is that it will help to publicise the race. In past races, newspapers and TV have not covered this event all that much. The competitors are rarely, if ever, seen and their positions are known only sporadically. The new tracking equipment will, however, make sure yachtsmen's positions are known all the time. Brian Nicholson, the *Observer's* managing director, sees this as a major reason for his company paying £100 000 to install the transmitters on each yacht.

The equipment is relatively simple, and takes up little space, but each unit costs over £3500. This is partly because it has to be robust enough to function reliably for up to a month in the violently moving, and often wet, environment of a small yacht. It is also portable

so that if the yachtsman has to abandon his boat he can, in theory, take the transmitter with him. However, in this event he will have to find some other means of telling race organisers and rescue authorities that he is in trouble. □

*This innocuous piece of equipment on a French yacht will keep shore-based organisers in touch with its position*





## Inventions win prizes—but not for Britain

The creative national genius that produced penicillin, radar, the jet engine, hovercraft and the linear induction motor was in scant evidence at the recent International Inventors' Exhibition in Geneva, now in its eighth year. Of a total of 545 exhibitors from 28 countries there were only three Britons. France led the pack numerically with 119 inventions on show, outstripping the Swiss on their home ground.

French presence was encouraged by the participation, for the third year running, of Anvar (l'Agence Nationale de Valorisation de la Recherche), counterpart of Britain's National Research Development Corporation. Anvar displayed 12 client offerings on a large collective stand, while other French exhibits were privately organised in a national group.

After Switzerland, with 105 inventions, came Italy with 96 in another independent collective. There were dozens each from Germany, Belgium and Spain. Even Australians outnumbered the British. Five of them travelled halfway around the world in an exercise promoted by a television programme.

At the 1978 Geneva exhibition, one of the top prizes went to an Australian for a cheap, simple solar tracking system powered by ordinary tap water. M.A.N. Neue Technologie of Munich was so impressed that it signed a licensing agreement with the designer. A third of the innovations at the 1978 show were the subject of contracts, the organisers claim, and the volume of business amounted to about SwFr 25 million.

Business agreements from the 1979 show are expected to top that figure. There were more than 90 000 visitors, of which many were company directors, industrialists and commercial agents looking for new ideas and products. An international jury of 40 experts awarded prizes on behalf of 15 Swiss and other sponsoring bodies.

The Grand Prix went to an Italian inventor, Franco Sala. He produced a plastic capsule that changes colour if frozen foods accidentally thaw at any time on their way to the consumer. Fitted to a window in the package, the tiny colour-change label contains two

chemical compounds. At deep-freeze storage temperature, they appear white. If the temperature rises above a critical level the compounds react and turn yellow or red as a visual warning.

A Swiss, Marcel Birukoff, won the Battelle Institute prize for a thermal-flux meter to check the insulation of outside building walls and measure heat loss. The portable electronic unit has an open rectangular chamber of known volume recessed on its underside, and rimmed by a rubber seal. When it is pressed against a wall the surface cools the trapped air, previously at room temperature. The temperature drop is measured for 20 seconds, which is timed



A sample of the gadgets on show in Geneva—none is British. Above Colour-change labels that show when frozen food has thawed or deteriorated; top right A thermal meter for buildings; bottom right An air-cleaning fan.

automatically by a starting plunger depressed by the wall. This drop is further related to the difference between indoor and outdoor temperatures, initially set on a dial. After the test period, the coefficient of insulation is instantly calculated and displayed on a digital readout.

Most of the inventions were relatively simple devices, but few were trivial. Typical was an air-cleaning fan, made by the Swiss company Castic, that removes dust, soot and smoke. The normal blades found on a fan are replaced by a circular rotor with a sandwich of thick blotting paper crimped to form radial ribs. Air sucked into the open centre of the disc passes through the hollow ribs by centrifugal force and is expelled at the rim. The turbulent internal flow



caused by rotation drives the impurities and particles against the paper surface which traps them.

Other gadgets with similar commercial promise included a geometric slide rule for fashioning the timbers of a pitched roof and other angled structures; a wall-mounted toothpaste dispenser that incorporates a brush-operated pump for one-handed operation; a magnetic hand-saw guide and square that provides dead-straight cuts without the width limitation or clearance wobble of a mitre box; and a low-cost electronic starting circuit for fluorescent lights made by a Korean. The device replaces the usual starter and choke and gives near-instant ignition with no flickering during start-up and reduced current consumption. □

## Building firms look to the 21st century

Increased R&D funds to raise the standard of buildings in the developing world could result from an investigation by the British construction industry into where it should spend its research cash. Construction firms in the UK spend far less on R&D, as a percentage of revenue, than other industries. The proportion is about 0.3 per cent while the figure for industry as a whole is 2 to 3 per cent. The total amount of research money could increase as a result of the two-year investigation, which should also produce new plans for the broad areas where the cash should be spent.

The Construction Industry Research and Information Association and the Institution of Civil Engineers are carrying out the work, which is funded by the Departments of Transport and Environment, and the Science Research Council. The aim is to identify research needs up to the year 2000.

According to Harry Nicholson of CIRIA, a strong possibility is that the industry will want to spend more on research geared to the needs of the Third World. British construction firms currently earn a large proportion of their sales through overseas work.

Over the next few months, about 80 experts in building will be asked to fill in a questionnaire on what the research priorities are. The emphasis will be on asking young people who will still be active professionally in 20 years. Among the technologies likely to be high on the final list are design in concrete and steel, aerodynamics, computer science and corrosion treatment and prevention.

Research aimed at optimising maintenance and repair work is likely to be highlighted. With the current slump in new building, this type of work accounts for 35 per cent of the construction industry's output when a few years ago it was 28 per cent. □

# Technology

continued

## Japanese join in set makers' enthusiasm for Prestel

Commercial prospects for Prestel, the British Post Office's viewdata service, appear to be looking up at last. Four of the major British set manufacturers have told the Post Office that they expect to produce a combined total of 900 Prestel sets a week by March, a figure that is 10 times greater than the rate at which the sets are currently being installed.

However, optimism due to this news is likely to be dampened by the circumstances surrounding an important trial of Prestel in the international business community. The trial will test the reactions to Prestel of about 300 firms in seven countries, but many of the sets the companies will use will boast not British labels, but Japanese ones.

To set up the trial, the Post Office gave the computer consultants Logica the job of finding a company prepared to make available the sets. The devices will be used in the next few months by business people in the US, the Netherlands, Sweden, Australia, Switzerland and West Germany, as well as Britain. Logica asked the major UK TV set makers but none was interested. However, Sony agreed to supply roughly half the 300 sets required. Electronic Rentals, a rental firm that will buy its sets for the trial from several different manufacturers, will supply the rest.

Sony has a production line in Bridgend that makes the sets, ready for a full market launch in April. Designed partly in Britain and partly in Japan, the units incorporate a 35-cm Trinitron tube and are aimed solely at the office user. There are three grades of set, which cost between £889 and £1365.

Sony is the first Japanese firm to express an interest in viewdata. The British industry was protected from

foreign competition by a Post Office moratorium that prohibited anyone other than a UK company supplying Prestel sets, but this expired in the autumn.

Factors that dissuaded UK companies from supplying the sets for the trial were, first, that the firm making them available had to agree to maintain the sets for the year that the trial will last. Secondly, the sets will be different from standard units fitted to the British Prestel network. They will contain the modems that "unscramble" telephone signals in a separate box outside the set, rather than as an integrated unit inside.

In Britain, demand for Prestel appears to be growing. There are now 2000 users, of which 1500 have been connected in the past year. All but 300 of the users are businesses, mainly in either London, Birmingham or Nottingham, which are the only areas so far covered by the public service. Edinburgh should be connected in March and Manchester in April. Thereafter the Post Office hopes to install Prestel computers at different parts of the telephone network at a fast enough rate to cover most of the country's major cities by the end of the year. The Post Office plans a £1 million advertising campaign in March to persuade people to buy or rent Prestel sets.

A clear trend among the set manufacturers is toward devices that are meant for business use only. This is away from the original concept for Prestel that it should be a service for householders and used in conjunction with TV.

The cheapest set, called Visa, is made by Pye TMC and costs £650 for a 22-cm monochrome display. ITT started producing in September a 40-cm version that costs £950. Output from the firm's Hastings factory is now 100 per week.

Four of the big firms—GEC, Philips, Thorn and ITT—say their combined production should soon be 900 per week.

A factor that has held up the production of sets has been the shortage of the "decoder" chips. These are included in the sets to translate telephone signals into lines of text that appear on the screen. It seems now that the supply problems are being overcome. The main suppliers of these chips, which are packed into a small box plugged into an ordinary TV set, are Texas Instruments and Mullard. These firms have recently been joined by GEC and General Instruments.

TI now says it is meeting demand by making 400 of the modules per week. Mullard, which is the supplier to Sony, has stepped up production to "several thousand per month". It plans to make 30 000 of the modules in 1980. Of the newcomers, GEC has a new production line that the company says is capable of supplying 100 000 chips over the coming year. □

## Better radio sound from Far East

BBC Radio has purchased a digital sound recording system from Sony of Japan. The system includes two U-Matic video cassette recorders and a Sony PGM 1600 digital-sound adaptor which converts stereo sound into digital code for recording onto video tape.

Engineers at the BBC have designed a synchronisation system with which the two recorders can be ganged together to let one machine take over from the other when the maximum one-hour tape length runs out during a long performance. The engineers successfully tried out the system over Christmas to record and re-broadcast a carol service from Kings College, Cambridge. Further use is planned for the near future.

The BBC's own engineering research department has experimented with digital-sound recording since 1972. The development has so far relied on encoding techniques which sample the original sound at 32 kHz, or 32 000 times a second, and digitally describe each sample with a 13-bit code. This standard conforms with the BBC's system that distributes programmes between studios and transmitters in robust digital form. It also accords with internationally agreed codes.

However, it has become clear that a sampling frequency of 32 kHz and a 13-bit code is inadequate for original master recording, where engineers need a greater sampling speed and bit code to obtain better audio quality.

The Sony system is the first fully tested professional package available and has a sampling frequency of slightly more than 44 kHz and a 16-bit code. The BBC purchase follows installation of similar Sony recorders in several American recording studios and suggests that the system may set a studio and broadcast standard. □

## Swedes build on a waste problem

Official pressure applied to its waste dumping activities has led a Swedish company into the unlikely sideline of property development. By constructing off Landskrona, Sweden, an artificial island of 3.75 hectares and releasing, during the next 10 years, 2.3 million tonnes of otherwise useless gypsum onto the site, Supra AB aims to provide people in the town with an impressive (and free) recreation area. Eventually the artificial island will be tree-lined and grassed.

The project dates from 1974, when the company was told to stop releasing gypsum, a by-product from the manufacture of phosphoric acid, into coastal waters. Although the material is soluble in brine, phosphates and heavy metals are considered an environmental hazard in the area of the Öresund Sea between Sweden and Denmark.

Shallow waters around the small island of Graen, a local bird sanctuary, made the company turn to the idea of land reclamation. Initially, the company removed 260 000 tonnes of rock, gravel and sand from the offshore area.

Dredged and drained, the dumping area was marked by stone dykes 4 metres high. This was divided into four polythene-lined pools.

Construction of the island's core is now under way. Gypsum slurry is pumped into the pools and water is drawn off at the rate of 8000 tonnes per day, to be returned to the mainland process. To avoid the water becoming contaminated by brine, engineers lined the canals with plastic. □



The artificial island takes shape



## Researchers sound out new testing technique

A research team at University College, London, has made an important advance in the new discipline of acoustic microscopy. This differs from conventional optical microscopy in that sound waves, rather than light, are beamed by a series of lenses onto the object to be examined.

The technique offers promise because the magnified image that the microscope provides depends on the object's structural and mechanical properties, as opposed to its reflective and refractive properties. Therefore the discipline could be very useful in non-destructive testing, for example detecting faults in microcircuits, and in the examination of biological specimens without the use of stains (*New Scientist*, vol 80, p 523).

Most acoustic microscopes built so far, however, offer resolution which is much poorer than that of an optical instrument. Researchers at Stanford University, California, have constructed acoustic microscopes whose resolution is as good as an optical device. But the Californian instruments that offer the best performance contain liquids at very low temperatures, sometimes near to absolute zero ( $-273^{\circ}\text{C}$ ) in which the specimens under examination must be immersed. By substituting for these liquids gases at high pressures, the London researchers say

they should be able to offer even better resolution, but without the inconvenience of cryogenic techniques. A further point is that the low temperatures in the Stanford devices can harm certain types of specimens.



One of the new acoustic microscope images. The width of the photo corresponds to about 200  $\mu\text{m}$

The two London workers, Kumar Wickramasinghe, who until recently was a member of the Stanford team, and Colin Potts, immersed the material under study in argon at 30 atmospheres pressure (*Electronics Letters*, vol 16, p 9). Sound at 45 MHz was beamed onto the specimen, scanning its surface in a raster mechanism. The resolution was 7  $\mu\text{m}$ , which is still a long way from 0.4  $\mu\text{m}$ , the maximum resolution that can be obtained with an optical microscope using green light.

However, by raising the pressure of the gas to 250 atmospheres, and increasing the sound waves' frequency to 2 GHz, the researchers predict that they will

obtain a resolution of just 0.1  $\mu\text{m}$ . The workers will discover whether they are correct in the summer by which time the necessary high-pressure equipment should be built.

The good results from the University College equipment are because high-pressure gas, in much the same way as a low-temperature liquid, slows down the passage of sound through it. A low velocity is required to produce rays that have a small wavelength and therefore a high resolution.

The problem with liquids such as water, specially if they are at room temperature and pressure, is that they absorb sound too much. What makes gases useful is that their absorption decreases at increased pressure while the speed at which sound travels through them, which is typically 5 to 10 times lower than for liquids under ambient conditions, is barely affected by pressure increases.

The major difficulty in the University College technique is in making sure that the high-pressure apparatus is safe and does not leak. In their new experiments due for the summer, the London researchers will use argon straight from a pressurised gas cylinder and pipe it to a 10-cm diameter pressure vessel which will contain the specimen under examination. □

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# US acts to clean up its act

Prevention is better than cure when you want to protect the environment

**Dr Jeremy Cherfas** The 1960s witnessed the realisation that the activities that supported the "highest standard of living in the world" were not an unmitigated blessing, and the voices of the newly fashionable "ecologists" became more insistent. It was at least partly in response to this clamour and increased awareness of "the environment" and its importance in health and disease that President Nixon created the US Environmental Protection Agency (EPA) in 1970. The new agency was an amalgamation of 15 environmental programmes that had previously been scattered through a variety of government departments, and Congress required it "to protect the Nation's land, air and water systems".

Almost a decade later, the EPA is now one of the largest regulatory agencies, with a budget of \$233.6 million for the year starting 1 October, 1979, and an impressive array of acts that enable it to carry out its job. To survey that job exhaustively would take a fat report. There are politicians who would like to see just such a report, and soon, before they will agree that the money is being well-spent. A briefer look at the EPA will give some idea of the complexity of the organisation, which, as a protector of the American citizen and his environment, must rank as one of the most important in the world.

Air and water were the two elements that EPA first turned its attention to. In 1970 the atmosphere above America received over 200 million tonnes of waste products each year. Just over half of this came from internal combustion engines. A quarter came from fuel burned at stationary sources, such as power plants, and the rest came largely from industry. Air pollutants cause and aggravate diseases—particularly those of the lungs, such as emphysema, bronchitis and asthma, but also heart diseases—and contemporary estimates had put the cost of air pollution—in medical treatment, lost wages and reduced productivity—at around \$4.6 thousand million a year. A further \$12.3 thousand million went each year in secondary damage, to, for example, buildings, crops and forests.

Control of air pollution is not new. It started in 1955, more or less, with federal research and technical assistance, and in 1963 Congress passed the Clean Air Act. This act required industry to reduce pollutants in the smoke from its chimneys; subsequent amendments have widened the scope of the act. The amendments of 1970 put responsibility for cleaning up the atmosphere in the hands of the fledgling EPA. The agency set national air quality standards, and these were supposed to be maximum allowable levels; the federal government can step in if states do not take action to ensure that these standards will be met. The amendments did not originally include any mention of money. Standards were set, and industry was told to meet those standards regardless of expense. As one critic recently wrote in *Fortune*, the house magazine of big business in America, this was "a logically surefire formula to make... costs infinite".

Clean air is not to be had easily or cheaply, as manufacturers were quick to point out and administrators slow to learn. In 1977 Congress further amended the Clean Air Act and went some way to recognising the problems. The amendments allowed more time—until 1982 or even 1987 in some cases—for states to meet the standards, and also told states to classify areas as either "attainment" or "non-attainment". Attainment areas are those where levels are below the standards for every pollutant. They must be kept clean, and are subject to special requirements designed to prevent significant deterioration. Non-attainment

areas, by contrast, are still over the limit for one or more pollutants. These areas are subject to different requirements that are, naturally enough, designed to reduce levels of pollutants and turn non-attainment areas into attainment areas as soon as possible, and in any case before 1982.

One problem that has beset the regulators in EPA is that they do not want to be seen to be stifling economic growth. At one time, a community that wanted to attract new industry would have to ensure that the new business added no pollutants to the atmosphere, which is plainly impossible. A new policy allows communities to "save" any reductions in emissions. The community can then allow new industry, provided that the pollution from that industry does not exceed the amount saved by reducing pollution from other sources in the area. This "offset" policy probably slows down the clean-up, but it does allow for continued growth, without which, industrialists say, there might not be a clean-up.

The air is slowly getting cleaner. Levels of sulphur dioxide, smoke and dust have dropped, and the rising trend in some pollutants, such as ozone and carbon monoxide, has flattened. But as residents of some cities, notably Los Angeles, are painfully aware, there is still some way to go.

Water is subject to much the same sort of control as air, although there are two major acts to implement that control. The Clean Water Act of 1972 is designed to make all waters in the US "fishable and swimmable", while the Safe Drinking Water Act of 1974 requires the EPA to "protect public health".

## Waste water must be clean

The Clean Water Act operates mainly to limit pollutants from specific sources, both industrial and municipal. As with Clean Air, the agency set limits on a whole host of pollutants and then told the polluters to meet the standards by 1977. Those that failed to clean up their discharge in time were given extensions for varying amounts of time, though none of these extensions is supposed to be valid beyond 1983. By that time, the EPA hopes, there will be a "zero discharge" policy. Waste water will not be allowed to contain anything other than water. An argument is currently raging between the regulators and the polluters as to what on earth this will mean. If the polluters take in dirty water, will they be forced to clean it up before they return it, or can they get away with not making it any dirtier? Nobody seems to know.

Where the Clean Water Act seeks to ensure that lakes and rivers are suitable for recreation, the Safe Drinking Water Act is designed, unsurprisingly, to ensure that the public is provided with safe drinking water. The surprise is that this should be a problem in a technically advanced country. The US surely has nothing to fear from its drinking water. But according to the EPA "more than half the facilities providing drinking water have serious deficiencies". The agency has created regulations that should ensure that all drinking water meets certain health standards.

Aside from these standards, which are essentially aimed at the treatment plants that supply drinking water, the agency is also charged with safeguarding sources of drinking water, especially underground sources. Many industries get rid of waste products by injecting the waste into deep wells. These wells could contaminate underground water, and the EPA must see to it that states do not allow subterranean disposal to affect the quality of water that might find its way into drinking supplies.

The Clean Air and Clean Water Acts are perhaps the





*The bad old days—San Francisco under a blanket of smog in June 1960, before the clean-up*

best known of the EPA's tools, but the agency is also responsible for safeguarding other sections of the environment and for regulating other types of pollutant.

Noise now has an act of its own—the Quiet Communities Act—but it was a part of EPA's brief from the start. The 1970 amendments to the Clean Air Act directed the EPA to study the effects of noise on public health and welfare and to report back to Congress. The result was the Noise Control Act of 1972 which later became the Quiet Communities Act. The agency sets standards of tolerable noise levels for all types of new equipment and machinery, and hopes that as new, quieter equipment replaces old, the noise levels in the environment will decrease. The ultimate goal is to reduce day-night sound levels to 55 decibels, an ideal level that "would be most desirable to achieve health and welfare protection" but which is probably not possible. In the meantime, the EPA wants environmental noise everywhere below 75 decibels ("a level at which there is risk of hearing damage") as soon as possible.

Solid waste is dealt with by the Resource Conservation and Recovery Act of 1976. This act requires the EPA to define hazardous wastes and to set standards for dealing with this kind of waste. It also encourages EPA to get into recycling, to ensure that there is as little true waste as possible and that valuable resources are recovered and reused. Office workers at the EPA have themselves taken up the challenge, and saved \$15 000 in the first two years of a paper-recycling programme.

Pesticides come under the aegis of the EPA through the Federal Insecticide, Fungicide and Rodenticide Act. The act goes back to 1947 but has been amended from time to time in an effort to keep up with changes in the nature of pesticide problems. Manufacturers must register pesticides with the agency, and the agency sees to it that operators are properly trained to use the more dangerous chemicals and that the labels on pesticides are comprehensive and correct. The agency also sets tolerance levels for pesticide residues in food.

Solid wastes and pesticides are both toxic chemicals; a recent piece of legislation—the Toxic Substances Control

Act—gives the EPA an almost impossible mandate to cover and control all toxic substances. The EPA can ban chemicals on suspicion and put the burden of proof on the manufacturer. If he wants to market a chemical, he must prove it is safe; the EPA does not have to prove it is dangerous. The EPA also has to ensure that any new chemicals are tested thoroughly before they are marketed by the manufacturer. In addition, the act set up an inter-agency committee in an attempt to catch up with the vast backlog of chemicals that came into use before there was the inclination or means to detect the damage they might do. This committee is supposed each year to draw up a list of 50 chemicals that the EPA should give priority to in its testing programme; if the tests on a chemical reveal significant risk the agency will be able to regulate manufacture of that substance.

The acts and amendments, rules and regulations, standards and limits, give the EPA great power in its attempts to protect the environment by controlling those who might harm it. But there are fundamental problems that beset the agency's efforts. One is the problem of radiation.

The EPA does have a programme in radioactivity, but neither the Toxic Substances Control Act nor the Resource Conservation and Recovery Act deals specifically with the detritus of the nuclear industry. The reason is historical; the Atomic Energy Commission and later the Nuclear Regulatory Commission were responsible for the nuclear industry, and the acts and amendments that mandate the EPA have never included control of radioactivity. Even so, the agency does have some influence. It establishes standards for protection against radiation, and has the authority to monitor radioactivity levels. The agency can also control the dumping of nuclear waste in the oceans. But the whole aspect of radioactivity forms a distinct deficit in EPA's battery of protective functions; when the subject is raised, sources close to the EPA administration smile discreetly and change the subject. Reform may be on the way, but until it arrives one major threat to the environment will not be under EPA's watchful eye.

The standards themselves are another problem, not just

because of the difficulty polluters have in meeting them but because the very rationale behind the standards is under fire. There is a National Toxicology Program (NTP) that gets money from a variety of sources and assesses the toxicity of chemicals. The NTP reports to the Surgeon-General, and can recommend limits to the various regulatory bodies, but the bodies are under no compulsion to use those limits. They may decide to impose much stricter, or much more lax, limits. The EPA at one time, early in its history, had a slightly cavalier attitude to standards. As one agency person told me: "We would tighten the screw, and industry would scream, but we could stand that and we'd keep tightening the screw. There would be a point when the screaming got so loud we could no longer stand it. So we'd back the screw off half a turn." That is certainly one way to set standards: where the standard is for a carcinogen, which might not have any "safe" level, it seems like a pretty good way. But it doesn't make the EPA friends in industry, and industry, after all, is responsible for producing the pollutants and must be made to stop.

The problem is that "scientific" standards are not necessarily any more helpful than screw-tightened standards. Dr Dave Rall, director of the NTP and head of the National Institute of Environmental Health Sciences, recognises this. "In the long term", he told me "we have to develop reliable batteries of tests that are accurate and useful. That's the way to set standards. But it's still a long way off." An EPA source agrees: "We need short-term tests for chronic effects. Soon."

The legislative weapons of the EPA are an impressive armoury, but the fight to preserve the environment is, unfortunately, not a fight that is to be won with weapons alone. Strategy and tactics are of far greater importance, and the agency, despite its firepower, has made some

blunders. In the early days it set standards and limits without regard to cost or technology. The idea was to impose "technology forcing" programmes that would require investment and innovation on the part of industry and government to succeed. And although the EPA has economic sanctions at its disposal, the cost of these was not judged very important by many polluters, who simply continued to pollute and more or less ignored the agency's deadlines and standards. Now, aware of the non-compliance of polluters and, indeed, of the impossibility of compliance in some cases, the acts are being amended. Deadlines have come and gone. Timetables have been altered. The principles of best available technology and best practicable technology now govern pollution reduction programmes, and there is money available to help polluters to comply with the standards.

These changes in tactics have been utilised by critics on both sides—and the EPA is in the unenviable position of being able to satisfy neither econuts nor ecovandals—to make the agency look foolish. But they do mean that the agency is more likely to achieve its overall strategy, of protecting the air, water and land of the US. Those who specialise in seeking portents from government action—and there are plenty in Washington—feel that the EPA is on the right track. Their main evidence is that Congress trimmed only a symbolic \$6 million from the 1980 budget, a clear sign to carry on the good work.

Doug Costle, administrator of the EPA, sees a shift in emphasis in the coming years: "I believe we are now on the threshold of a new era... in which the after-the-fact attempt at corrective action... will give way to... before-the-fact techniques of resource management and public health protection." That will be fine when it comes, but first the after-the-fact clean-up will have to succeed. □

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# US aid at the crossroads

The changing reality of economic development has—for the first time in 20 years—forced the US to reappraise its entire approach to aid

**Stephanie Yanchinski**

Was the United States Senate really playing Scrooge when it denied funds for the proposed Institute for Scientific and Technological Cooperation? Did the ISTC really have a crucial role to play in promoting America's Third World research? How does the government's reluctance to give \$25 million to ISTC square with repeated assurances at the UN Conference on Science and Technology for Development of at least \$25 million for UNCSTD's action programme?

The controversy and confusion, the inconsistencies that surround the future of ISTC, are but aspects of a general plan to reorganise American foreign aid policy to bring it in line with the realpolitik of today. The last major upheaval, in 1961, created the US Agency for International Development (US AID). Since then, the total foreign assistance budget has swollen from \$2.2 billion (thousand million) to over \$7 billion in 1979. And there have been other changes. Subscription payments to the international development banks, such as the World Bank, amounted to a mere 2 per cent of the foreign aid budget in 1961. Today, a large proportion of the aid budget, \$2.5 billion, is paid into these banks. In 1961, the United Nations Development Programme (UNDP), destined to play a crucial role in the UNCSTD action programme in 1980/81, had not even been created. Today it is the largest UN source of Third World aid and last year received about \$126 million from the US. Most important of all, two decades ago the day of energy power politics had not dawned, with all its implications for the balance of power between the developed and the developing world.

For example, much valuable aid money is spent on high technology remote sensing satellites such as Landsat, which not only maps crop yields and soil moisture in arid areas—of direct benefit to the participating developing country—but also can spot oddly-shaped geological formations, the precursor to oil or mineral finds. In some cases only the US has the technology to exploit these finds. To some critics, spending money in this way is at odds with the so-called "basic needs" policy, which has underpinned aid strategy throughout the 1970s. This strategy aims at improved public health care, more food and better nutrition, and better water sanitation and housing; it generally eschews the transfer of high technology and industrialisation.

But President Carter himself, in his submission accompanying the US foreign assistance reorganisation plan, pointed out severe shortcomings inherent in the administration of aid until now. These shortcomings limited the effectiveness of American aid dollars.

Because no one agency or organisation was responsible for coordination of aid, the Department of State, the Treasury, US AID and other government departments often initiated programmes that were incompatible with one another and with overall foreign policy. And because there was no authoritative spokesman, development was not given sufficient weight in Executive Branch decisions on trade and other non-aid economic issues that affect developing nations. Sidney Weintraub, former deputy assistant secretary of state for international finance and development, commented prior to UNCSTD that "there has been no philosophy guiding our actions... As a consequence, policy has veered from intense confrontation to temporary truces."

So, on 1 October last year, IDCA—the International

Development Cooperation Agency—was born to play this crucial role of guidance. IDCA's director, Thomas Ehrlich, is now the President's principal advisor on development matters. IDCA is slated to set overall development policies, coordinate, and ensure proper balance between different bilateral and multinational aid programmes. More importantly for American support for Third World R&D, IDCA's director is required by law to "participate" in Executive Branch discussions on such issues as "trade, and investment, science and technology as they affect the developing world" (*Reorganisation Plan No. 2 of 1979. Report of the Committee on Governmental Affairs, United States Senate, US Government Printing Office, Report No. 96-210*).

Placing "trade and investment" side by side with "science and technology" in the report is no accident, for renewable energy resources is listed as one of the first things that IDCA should consider, and has both economic and research implications. (IDCA will also look at human rights, population, nutrition and the environment.) There is clearly a move afoot to reorganise American science and technology aid from an economic point of view.

Ehrlich spelled out the importance of the Third World to the American economy in a recent address to the Council of Presidents of the National Association of State Universities and Land Grant Colleges. "Foreign aid serves our economic and political interests," he said. "The non-oil exporting developing countries are a major and the fastest growing market for US goods. They already buy over one-third of our exports—the same share as for

## Third World aid from industrialised countries

| Country            | 1976 aid<br>US \$ million | 5 per cent for<br>Third World<br>R&D |
|--------------------|---------------------------|--------------------------------------|
| <b>Western</b>     |                           |                                      |
| Australia          | 385                       | 19-25                                |
| Belgium            | 336                       | 16-80                                |
| Canada             | 885                       | 44-25                                |
| France             | 2152                      | 107-60                               |
| German (Fed. Rep.) | 1309                      | 65-45                                |
| Japan              | 1093                      | 54-65                                |
| Netherlands        | 718                       | 35-90                                |
| Sweden             | 607                       | 30-35                                |
| United Kingdom     | 827                       | 41-35                                |
| United States      | 4304                      | 215-20                               |
| Others             | 896                       | 44-80                                |
| <b>Total</b>       | <b>13 512</b>             | <b>675-60</b>                        |
| <b>Socialist</b>   |                           |                                      |
| Bulgaria           | 8                         | 0-40                                 |
| Czechoslovakia     | 1064                      | 53-20                                |
| German Dem. Rep.   | 105                       | 5-25                                 |
| Hungary            | 20                        | 1-00                                 |
| Poland             | 52                        | 2-60                                 |
| Romania            | 261                       | 13-05                                |
| USSR               | 1208                      | 60-40                                |
| <b>Total</b>       | <b>2718</b>               | <b>135-90</b>                        |

Source: Transfer of Resources in Real Terms to Developing Countries, United Nations Conference on Trade and Development document A/C.I.A.C. 19/7, 13 April, 1978.

Most of the financial assistance the Third World receives is as tied aid. One popular suggestion at UNCSTD to raise more money specifically for R&D was to set aside 5 per cent of these aid funds for research and channel these funds through institutions such as the proposed ISTC

Europe and the Communist countries combined." He went on to add that over a million jobs now depend on exports to the developing countries and the US earned more than \$16 billion from direct investments in the Third World in 1978. "For every dollar we have paid into the World Bank, for example, about \$2 has been spent in the US economy."

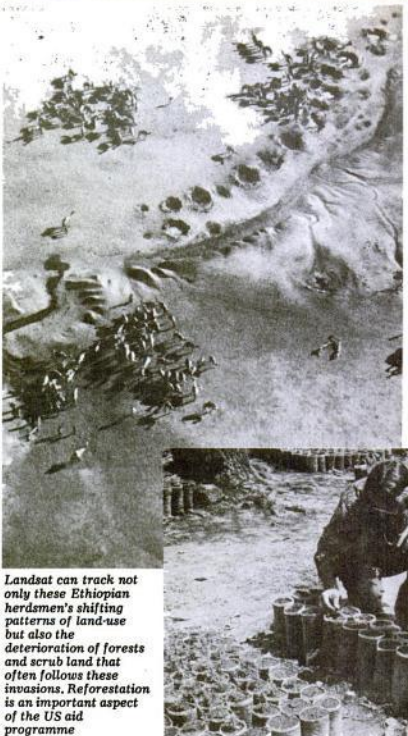
Originally, ISTC was to be free of such economic and political pressures, from which US AID, with its massive budget of \$1.77 billion and its close links to the State Department, cannot escape. Its governing board originally was modelled on the highly successful and innovative Canadian International Development Research Centre, and consisted of American and Third World experts. Early ISTC supporters—such as Adlai E. Stevenson—envisioned that this very strong independent board, completely free of US AID, would have made sure that ISTC's work grew out of Third World needs and problems, and not out of American foreign policy.

But the ISTC was designed to play another important role: coordinating American Third World R&D. At present this R&D is scattered throughout government departments, universities, academic institutions (such as the National Academy of Sciences) and private bodies (such as the Rockefeller and Ford Foundations). ISTC was not designed to operate its own research programme but by making grants and signing contracts to "focus increased scientific and technological attention on problems [of the American research community] relevant to development." Without one authority responsible for American Third World R&D, many simple facts remain obscure. For example, no one knows how much American money is spent on research that could be said ultimately to benefit the Third World. One study claims to have identified more than \$1 billion spent in US-supported projects that involve significant scientific and technological "components".

#### Government support

One organisation that has tried in the past to link up scientists, technologists and social scientists with their counterparts in the Third World is the Board on Science and Technology for International Development (BOSTID). The board is a division of the National Research Council's Commission on International Relations, and is responsible for programmes with developing countries. Over the past 15 years BOSTID, under energetic leadership like that of its current director, Victor Rabinowitch, has organised workshops in developing countries on certain specific problems in agriculture, environmental planning, energy, forestry, health, management and conservation of natural resources, nutrition, and water supply and quality. US AID and other government departments frequently tapped BOSTID's advisory panels of experts for advice on R&D and development. BOSTID's Advisory Committee on Technology Innovation (ACTI) brought the potential of simple technologies for solving development problems to the attention of scientists and technologists in the developed and developing world alike. For example, its study on fast growing bushes and trees uncovered several species which could solve the firewood shortage that faces many Third World countries. (And, incidentally, ease the pressure on energy resources throughout the world.) Other studies highlighted under-exploited tropical plants such as the winged bean, at present grown only in Papua New Guinea and other parts of South-East Asia. The winged bean could meet not only the dietary protein requirements elsewhere in the tropics but also supply needed Vitamin A, and as its roots fix nitrogen, it saves on precious fertiliser. Leucaena, guayule and jojoba have also been ACTI "finds".

But BOSTID has done more than redress the Green Revolution's emphasis on breeding new varieties; it has pushed plant research back towards exploiting local varieties of plants. BOSTID has attempted to do what last



*Landsat can track not only these Ethiopian herdsmen's shifting patterns of land-use but also the deterioration of forests and scrub land that often follows these invasions. Reforestation is an important aspect of the US aid programme*

August's UN Conference on Science and Technology for Development recommended should be the major aim of any agency involved in Third World R&D—strengthen the local capacity for R&D and encourage self reliance. BOSTID-sponsored workshops held in developing countries including many of the land-locked, least developed, have tried to answer such questions as what kinds of organisations and institutions are needed, what kinds of policies, and what types of people need to be trained and how?

BOSTID, unlike the visionary ISTC of several years ago, is not an independent agency; it gets most of its money from US AID. Another academic institution involved in promoting Third World research at home and abroad is somewhat more independent. The National Science Foundation receives all its money from Congressional appropriations as an independent federal agency like NASA.

Originally set up to promote science in the United States, the NSF has been criticised as being too aloof from down-to-earth Third World problems. The head of the Division of International Programs, Bodo Bartocha, admits that only 10 or 11 per cent of NSF's \$1 billion budget goes on the applied research that is more likely to fit Third World needs. This illustrates one of the common failings of



American aid for Third World R&D—there is little money to commercialise the promising findings of basic science research. But as the NSF's stated policy is to set up cooperative programmes "to benefit the US", this is hardly surprising.

The NSF currently operates more than 300 cooperative projects in over 40 countries, mainly in Europe and Eastern Europe. But of the Third World countries, the NSF has until now been involved mainly with those that possess advanced and well-recognised capabilities for science and technology, such as Brazil, Mexico and Venezuela. One programme financed by US AID, which NSF has participated in, gives needed technical assistance to even the poorer developing countries. Under SEED—scientists and engineers in economic development—US scholars work with their counterparts in developing countries on a one-to-one basis, doing research and teaching at institutions in the host country.

As a result of UNCSTD, the NSF's governing board proposed four new cooperative programmes to help meet new criteria that push aid in favour of the developing countries; it claims that these would involve no new staff and would cost \$950 000. The NSF recommends that 20 annual dissertation support awards be provided to encourage MA or PhD research that is particularly relevant to Third World needs. Another idea for Third World academics is short courses to provide more practical training in curriculum planning and how to develop and repair scientific instruments. These courses would be designed to "top off" their educational experience in the United States and "ease their readjustment" when they return home. NSF also wants SEED to be expanded to include more Third World countries and scientists. And finally, more money should be allocated to travel funds for Third World participants in NSF cooperative programmes to visit US agencies, institutions and colleagues. Until now NSF money has been available only for American scientists to travel to the developing country. But Bartocha is one of those who feels these recommendations do not go far enough—that a better role for the NSF would be to develop Third World ability to make scientific policy and management decisions by providing more consultancy services in assessing science needs and manpower.

### Private funds

Aside from the NSF, which is government funded, other sources of grant money lie in the hands of private institutions such as the Rockefeller and Ford Foundations.

Through grants and fellowships, the Rockefeller Foundation supports research aimed at controlling the world's population explosion. Rockefeller projects include work on reproductive biology and contraceptive technology, and tackle the broader socioeconomic issues that influence family planning in Third World countries. Another objective of the foundation is to improve the world's supply of food by doing more research into new food legumes, parasitic diseases of animals, promising aquatic plant species and new approaches to plant breeding.

To draw attention to what it calls the "great neglected diseases", the Rockefeller Foundation has established a network of 10 units around the world; the Tropical Medicine Research Unit in the Nuffield Department of Clinical Medicine at the University of Oxford is one. These units research diseases which have largely been ignored until recently and yet afflict hundreds of millions of people—schistosomiasis, hookworm, malaria, and amoebic dysentery. The foundation is not very wealthy—in 1979 it spent \$33 million on all its grants and special fellowship programmes.

The Ford Foundation covers much the same areas—agricultural and rural development, economic and social policy, education and population. But its programme budget is much larger—about \$100 million. Last year, for example,

the foundation made 25 grants totalling \$1.5 million just for research and training in reproductive sciences in six countries—Argentina, Canada, England, Ireland, Thailand and the United States.

What of the future? Questions about possible increases in spending on Third World R&D beyond the \$25 million likely to be pledged to the UNCSTD action programme bring a very muted response among Washington government circles. But there are some bright spots. In November the International Cooperation Development Agency announced a new international energy training programme for developing nations. Thomas Ehrlich, ICDA's director, said that this programme "could become one of the largest single economic development training programmes ever undertaken by the US government". The new programme will offer fellowships for training in energy-related fields up to doctorate level and is expected to enroll its first students in September 1981.

The National Institute of Allergy and Infectious Diseases (NIAID) recently announced a new programme that over the next five years will provide awards to six American institutions and five individuals to work with counterparts in developing countries. There will be ready money for travel to the US. NIAID also proposes to establish tropical disease research units in the US, but mainly to train American scientists.

### Non-profit corporation

The problem not tackled by American aid—of how to translate this research into commercially profitable drugs—remains, for pharmaceutical firms are notoriously loath to fund expensive research with no solid commercial winner in sight. One exciting solution might be a non-profit health corporation, merely a gleam in the eye of the Rockefeller Foundation at the moment. Such a corporation would undertake fundamental vaccine research and pass on potentially valuable preparations to the drug firms for commercial exploitation.

But many within the American academic community believe that even from the narrow point of view of self interest the US has a lot to gain by supporting Third World research. Princeton Lyman highlights three areas—vaccines, using genetic manipulation techniques; forestry; and new crops which can grow on marginal lands—where co-operative research could bring benefits at home. These do not currently receive nearly enough money.

A recent Office of Technology Assessment report, *Pest Management Strategies in Crop Protection*, estimates that integrated pest management (IPM), which relies on a variety of techniques to control pests, could cut pesticide use for major American food crops by 75 per cent. "After all, we are losing our forests too," he said. At the same time the worldwide adoption of this approach could save a substantial share of the one-third of the world's food harvest that is now lost to pests.

The major obstacles to rapid adoption of integrated pest management that were highlighted in the report include problems that are distressingly familiar to those engaged in the US's Third World research effort: "shortage of trained personnel to do the research, the lack of coordination and cooperation among federal and state agencies and the lack of clear commitment to future IPM activities . . . by agencies involved in the funding of research and extension activities, regulating pesticide use and marketing farm products."

We may never know how the shelved Institute of Scientific and Technological Cooperation might have solved these intricate problems. The highly successful Canadian International Development Research Centre proved what a small group of committed and enthusiastic experts—dedicating their careers to encouraging self-reliant research in the Third World on Third World problems could do. □

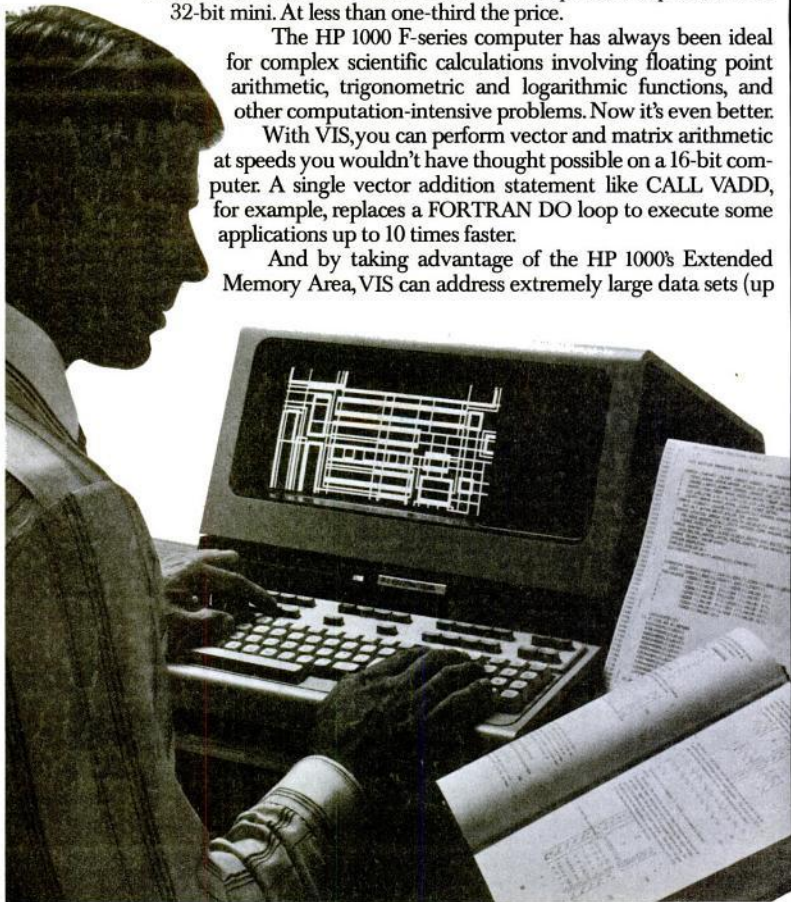
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# Review

## Intelligent technology

### The computer age

edited by M. L. Dertouzos and J. Moses

MIT, pp 491, £15.50

*Private Eye* recently introduced a satirical "Guide to the Ayatollahs of the World" by announcing that the guide had been produced with the help of the miraculous micro chip. This neatly encapsulated the way in which the media have seized on the chip to try to inject some trendy new life into their standard hack approach which grinds major world events and trivial gossip into the same inedible mish-mash.

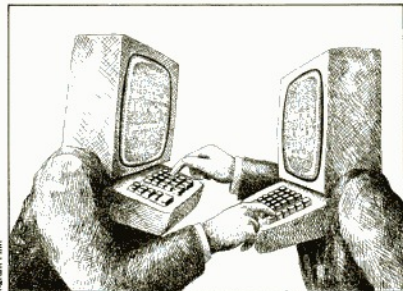
At last, however, there is a book of sufficient depth and understanding to match the magnitude and complexity of the information technology "revolution" which is being spread by the low-cost computing power and data storage capability provided by the ubiquitous silicon chip. *The Computer Age: A Twenty Year View* was conceived in 1974 during an international computer conference shortly after Michael Dertouzos and Joel Moses had been appointed to lead the MIT Laboratory for Computer Science.

In thinking about the future direction that should be taken at their laboratory following discussions with fellow computer scientists at the conference, Dertouzos and Moses found themselves faced with an apparent contradiction between the visionary claims about the predicted information revolution and the reality of the first two decades of computer usage. They asked themselves how they could reconcile the reality of computers which made simple-minded errors in carrying out mundane processing tasks, with the prospect

of intelligent machines which could shape or even dominate the future of mankind.

Dertouzos and Moses decided to invite contributions from a variety of specialists with either a record of predictive or analytical ability in their speciality, or the power to initiate change by virtue of their position. This book is the result: a selection of 19 essays plus a comment on the whole book by Joseph Weizenbaum, a professor of computer science at MIT and one of the most incisive critics of the direction being taken by computer science.

The editors provide comments at the end of some essays to highlight any points that may have been missed, played down or over-emphasised. A consistent theme is the general consensus that microelectronics will continue to provide improvements in the price and capability of hardware machinery but that the breakthroughs needed to turn advanced computing ideas into reality will have to come from traditional computer science subjects such as sys-



tems analysis and software engineering.

In his vital critique at the end of the book, Weizenbaum makes some sharp comments against the prevailing mood of technological optimism. He suggests that, far from enhancing the quality of life, computers for "the masses" will turn out like worldwide TV, which he describes as "offering an occasional gem buried in immense avalanches of the ordure of everything that is most banal and insipid or pathological in our society". He believes that the obsession with computer games in which the main objective "is to kill, crush and destroy" indicates that home computers will follow the "same calamitous script" as worldwide TV.

Weizenbaum fears that computer scientists and other relevant technological experts will see "the emperor's new

clothes more vividly than anyone else" and fail to provide the rest of the world with the understanding to provide answers to crucial questions. However, *The Computer Age* provides an excellent basis for a considered analysis of the future options opened up by information technology—particularly as it contains Weizenbaum's trenchant views as a backcloth to the other more bullish technological opinion.

And for those Europeans who still cherish the belief that while the Americans may be good at building and selling products but less sophisticated than Europeans in their objective philosophical analyses of issues, the intellectual breadth of this book, written by authors all based in the US, should provide a sobering antidote to any lingering Old World chauvinistic feeling of intellectual superiority. *Malcolm Peltu*

### Lying truths

compiled by R. Duncan and

M. Weston-Smith

Pergamon, pp 242, £7.50

At first sight *Lying truths*, subtitled "a critical survey of current beliefs," is intriguing. When household names like Arthur Koestler, Peter Medawar, Otto Frisch, Alan Cottrell and Colin Wilson set out to expose the fallacies in widely-held views, the appetite is certainly whetted. But don't drool too soon. This successor to the *Encyclopaedia of Ignorance* is seldom better than an encyclopaedia of rhetoric and bias. The "compilers" are right to disclaim any editorial function. They seem merely to have invited contributions, never saying "This is too long/short/

complicated/boring", or if they have, they have not often been regarded. One or two eminent names are content to recycle a few ideas from earlier works. Others gleefully mount hobby horses or set up Aunt Sallies for the coconuts of prejudice.

On the whole, cobblers who stick to their lasts fare better. Rhodes Boyson discussing the fallacy that state education raises standards takes a predictable line, but he knows his evidence and organises the arguments well. Hermann Bondi, on the other hand, chooses to attack all religions, condemning practices largely abandoned hundreds of years ago. Noting that crusader is generally a term of approval, he observes that "crusaders were nothing but a disgusting gang of self-opinionated vicious

invaders and slaughterers robbing and murdering wherever they went". True up to a point, but see Koestler in the previous essay for exposure of the "nothing but" fallacy.

Extremism, over-simplification and wild generalisation abound. The astronomer R. A. Lyttleton asserts that "only when proposed solutions are put in mathematical form is there provided a worthwhile basis for discussion". He has begun his article with a three-page mathematical proof of the notion that if there is a slight preponderance of people who believe an idea, a consensus will tend to form around it. Suspicions that this is some sort of academic joke fade before the pages of discussion which follow.

There are some entirely

respectable contributions. If you think this is the way to acquire an explanation of elementary statistics, Otto Frisch provides it. Paul Davies performs a similar role for quantum physics. If you haven't time to read Thomas Szasz's many books, he summarises lucidly some of his iconoclastic ideas on psychiatry. The most surprising essay is Peter Walker's plea for better conditions for Britain's poor blacks. The silliest is Miranda Weston-Smith's attack on the mass media. She seems to think that the *Daily Mirror* should take over the function of the letters pages of *Nature*, and that Henry Moore or Graham Greene would actually be willing (never mind able) to edit an arts programme if asked. *Judith Mirzoeff*



## The ecology of vision

by J. N. Lythgoe

Oxford UP, pp 244, £22

This is a most interesting book. It brings together for the first time data and ideas from the study of the web of inter-relationships between an animal's visual sense, its behaviour and the ecological conditions under which it lives. These ideas are drawn from a wide range of specialist fields ranging from pure physics through oceanography and visual science to ethology. The general theme has a long pedigree and in recent years conference papers and review chapters have shown a revival of interest and a new level of understanding. These have concentrated on specific topics: this book attempts a synthesis.

It is difficult to say who should read a visual science book as broad ranging as this. It will certainly provide enlightenment for anyone interested in the senses, whether they call themselves physiologists, psychologists or ethologists, and also for that increasingly rare breed of

zoologist interested in the whole animal in its real environment.

The book begins with the nature of the light environment and the mechanisms of vision. We are given some idea of the range of light intensities and spectral distributions which occur naturally. It is particularly useful, for instance, to have colour plates which give some idea of the "true" colour of the underwater environment. Those of us used to photographs of artificially-lit fish simply do not realise that the aquatic space light can be so decidedly coloured and that the bright hues of a fish's markings are completely changed when we see the animal in its natural environment.

This section is not entirely successful, however. Despite the author's efforts, the non-visual scientist will still be bewildered by the complexity of light measurement and the units in which they are expressed. (An appendix would have helped.) Perhaps the main inadequacy, and this runs throughout the book, is the use of figures which too often have

been lifted from other publications with captions insufficiently altered to help the reader. Figures sometimes appear without being referred to in the text and often references are to the wrong figures or plates.

The author is most at home in considering vision in aquatic environments and the problem of vision through light scattering media. The colour biases of water pose special problems and Lythgoe shows elegantly how the spectral sensitivity of the visual pigments of fishes can be most clearly understood in terms of matching or offsetting maximum sensitivity to the space light distribution. The colour plates help again here.

The weakest part of the book deals with vision in clear, non-colour-biased environments: the typical visual environment of terrestrial creatures. Here evolutionary adaptationist arguments fly thick and fast, especially in the chapter on camouflage and advertisement, and hypotheses are not rigorously stated. The thorny old problem of the adaptive significance of animal color-

ation is raised again but not all the alternative hypotheses are reviewed. However, it would be invidious to take Lythgoe to task on any particular argument since the basic problem is lack of data. Certainly there seem to be many interesting and tantalising relationships concerning visual capacity and the visual nature of tasks which the animal seems to face. Yet Lythgoe should have been a little more explicit in pointing out the weaknesses in his arguments and the sometimes inadequate data on which they are based. Perhaps this would enhance the inquisitiveness of his readers and accelerate the collection of the vital data.

The price is outrageous. A book of this nature, a synthesis full of ideas, should be as cheap as possible. It shouldn't be a book just for the library shelf. Students and specialists from many fields, even those outside biology, having read this book could contribute to the advancement of visual ecology. But they won't casually buy a book at this price to see if it interests them. *Pity!* Graham Martin

## A miscellany of molluscs

You might think *Seashells* by Peter and Patricia Newell (Phaidon, pp 120, £6.50) was just any one of those picture books containing nice photographs with a meandering low-key script. But closer inspection reveals that, as well as the expected beautiful photographs, it has a well written informative text, which should be useful, not only to the average naturalist and collector for whom it is designed, but also as an older children's reference source.

About two-thirds of the volume is devoted to a survey of various molluscan groups (with shells), while the rest includes background information on anatomy, biology, marine ecology, fossils and collecting.

A field guide to the land snails of Britain and North-West Europe by M. P. Kerney and R. A. Cameron (Collins, pp 288, £5.50), also a naturalist's book, will undoubtedly be used by a variety of students and some professional biologists as well. The format is like that of the other Collins "guides", in this case with 408 coloured plates and additional black and white



diagrams, as well as many distribution maps. Descriptions of snails and slugs are given, along with biological and taxonomic notes. In addition, guidance for snail hunters includes directions on the preservation and mapping of these animals.

It is worth noting that this is the first volume, since that of Ehrmann (1953), to detail the land snail fauna of more than one Western European nation.

E. R. Kandel's *Behavioural biology of Aplysia* (Freeman, pp 463, £25.20, ppb £11.60) falls into a different category and is essentially a comparative review, designed for use

as a text book by those studying mollusc neurobiology and behaviour to a fairly advanced level. Intended primarily as a handbook on the opisthobranch *Aplysia*, it also aims to bring together an extensive literature which has appeared since Nellie Eales's 1921 monograph and forms a companion to Kandel's other item, *The Cellular Basis of Behaviour* (1976).

**Submolecular biology** and cancer edited by G. E. W. Wolstenholme, D. W. Fitzsimons and Julie Whelan (Excerpta Medica, pp 349, £42.50). After spending \$3000 million on research, we understand cancer no better than did Rudolph Virchow a century ago. Albert Szent-Györgyi makes that claim at the very end of this book. It is the proceedings of a recent Ciba Foundation Symposium, dedicated to this distinguished yet unconventional biochemist on his 85th birthday.

We might therefore assume that the conference, which reviewed electronic theories of malignancy, was as much a failure as other efforts to discern the fundamental nature of cancer. That would be a mistake. There is much

The present book has chapters on comparative biology, the aplysian nervous system, abdominal ganglion and interactions between central and peripheral regions. Other sections deal with development, learning, behaviour and the senses. There are also many clear diagrams and a comprehensive bibliography.

*Peter J. Baron*

evidence here, not least from the vigorous discussion sections, that Szent-Györgyi's heterodox speculations have been and continue to be constructively catalytic.

The overall impression that emerges is that, whatever the truth of the great man's specific ideas and complaints ("Biologists have taken no notice of electrons"), he is right that a thorough understanding of cancer will be possible only when we can describe more adequately the nature of life in a normal cell. Few scientists would go all the way with Szent-Györgyi in abandoning, for the moment, research towards a cure. Few, however, will query the man's contagious creativity in a field that is woefully short of ideas.

*Bernard Dixon*

# Review

continued

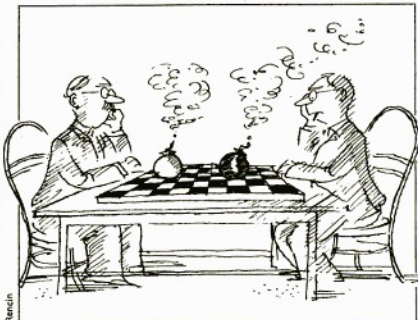
## Endgame: the inside story of SALT II

by Strobe Talbott

Harper and Row, pp 319, £7.50

*Endgame* is instant history. It describes the main events of the final 2½ years of the SALT II negotiations—from President Carter's dramatic (but abortive) offer to the Soviets, in March 1977, of sharp reductions in the number of deployed strategic nuclear weapons, to the signing of the treaty in Vienna in June 1979. But the actual end of the SALT II story may be anti-climatic—the treaty may not be ratified.

Strobe Talbott, foreign affairs columnist for *Time* magazine, explains what SALT II is, how it came about, what happened at the negotiations, and what was said (and why) by each side during the talks. Talbott bases his account on on-the-spot coverage of SALT II affairs since 1974. A good sprinkling of corridor chit-chat shows his close acquaintance with these events. He went to Moscow and Geneva with US Secretaries of State Henry Kissinger and Cyrus Vance,



and was in Vienna when Presidents Carter and Brezhnev signed the treaty. American officials in the Nixon, Ford and Carter administrations, Soviet officials in Washington and Moscow, and Western diplomats gave him much inside information not otherwise available in the relevant literature.

The story focuses on the

major and minor actors in the negotiations. The human side emerges from graphic descriptions of Cyrus Vance's rivalry with Carter's aggressive Special Assistant for National Security, Zbigniew Brzezinski; Defense Secretary Harold Brown's sparring with Chief SALT negotiator Paul Warnke; the role of the head of the CIA, Admiral Stansfield Turner; and

the often crucial influence of such experts as Kremlinologist Marshall Shulman, Vance's special consultant on Soviet affairs, and Leslie Gelb of the State Department's Bureau of Politico-Military Affairs. But perhaps the most interesting anecdote is how Soviet Ambassador Anatoly Dobrynin, with Vance's eager help, established himself as Russia's indispensable negotiator.

So far as I can discover, *Endgame* is an accurate account of the last phase of the SALT II negotiations. It is excellent journalism with a good dash of history. But it is short on analysis. In particular, the objections of American hawks to the treaty are not adequately spelt out: nor are the implications of SALT II for the Europeans or even the consequences of a failure of the US Senate to ratify the treaty. This may be unfair criticism. Adequate analysis takes time and *Endgame* was written while the events it describes were actually happening. Undoubtedly, it is essential reading for all interested in arms control and disarmament negotiations.

Frank Barnaby

## Science, technology and global problems

edited by J. Gvishiani

Pergamon, pp 400, £30

Pergamon are issuing four volumes of reports from symposia held as part of the preparation for the UNCTD conference earlier this year. Three of the four volumes cover symposia held in the Third World, but this particular one deals with material presented at Tallinn in the USSR. Most of this material comes from Soviet scientists, and there is the usual splattering of quotes from Party Secretary Brezhnev.

As is the case in many conference reports, the combination of papers is rather bizarre. A contribution on "Mathematics and Progress in Science and Technology" follows a piece on the "Irreplaceability of the Soil Cover in Nature", for example. Various contributions interpret the "global problems" of the title in different ways. Some articles are basically futurological explorations of the evolution of science and technology; others focus on science and scientists as inputs to Third World de-

velopment issues; and yet others are raising points about cooperation in order to cope with world crises.

The varied assortment is daunting rather than stimulating, since there is hardly any integration of the diverse theories, and the leavening of programmatic statements from international organisation officials is anything but effervescent. The latter have been rather overtaken by the events around UNCTD itself, and rather more insight into the interests and manoeuvres at that jamboree can be gleaned from the pages of *New Scientist* during last summer's conference.

What is of interest, however, is the attitude displayed by the Russian contributors to the volume. Summarising ideas from various chapters, the view seems to be that science and technology are basically neutral, but their beneficial potential is only realised in certain social conditions (the familiar "use-abuse" model). It can hardly be claimed that Russian-style socialism is a prerequisite for technological progress, and Western forecasts are often cited (although the home-grown variety,

especially where predictions of the future of the physical sciences are concerned, make good reading). But in the West, science will be used for corporate capitalism's ends, and only humanist forces (including scientists' organisations) have prevented domestic damage being wrought as it often is in the Third World. In contrast, the Soviet Union is held to embody a humanist ethic at the heart of the social formation, and thus whatever problems arise these are a matter of a learning process and can typically be rapidly corrected with very little trouble.

Unfortunately, the socialist-humanist practices which might turn this account into reality are glossed over; instead we read quotations from the constitution, speeches, and long discussions of humanistic ethics for science. No social antagonisms seem to come anywhere near Soviet science in these accounts, in marked contrast with the discussion of the situation elsewhere. So perhaps it's only capitalism bewildering our anti-nuclear movement (which includes, of course, humanistic scientists among others) and making them disagree with such

Soviet claims as "thermonuclear reactors are needed everywhere" and that waste plutonium should be dumped on the Sun. Thus the way to deal with such antagonisms is to steam-roller them into non-existence: seeking to slow down nuclear expansion "is very alarming... all measures must be taken to overcome difficulties in the way of the speedy implementation of these programmes on a broad scale". All measures? The feeling grows that the establishment science of the Eastern bloc would do well to scrutinise its own social bases with the vigour it applies to Western power structures.

This is not a book for casual browsing, though the translations are more readable than most. Most of the ideas contained in it will be familiar to followers of the futures and development debates although there are healthy claims for the significance of social factors, even where these are not always followed up with analysis. Although global problems confront us all, if Russian solutions continue to be packaged in this sort of format, very few of us are likely to sound them out.

Ian Miles



**Genetic counselling:****psychological dimensions**

edited by Seymour Kessler

Academic, pp 248, £11.70

As our ability to diagnose actual and potential genetic defects in people before birth grows, many new questions are raised for society to tackle. Some are ethical and legal, as with attitudes to abortion; some are essentially political, since the whole concept of genetic counselling still conjures up for some people an image of plots to breed a master race; but in this book the previously rather neglected psychosocial issues are tackled. The

authors present compelling evidence of the need for skilled and compassionate genetic counselling, while the editor has ensured that the book is readable and informative.

Genetic disorders occur among nearly 5 per cent of liveborn infants, and probably an equal number not diagnosed until symptoms appear in later life. So perhaps as many as 10 per cent of the population may at some time need the advice of a genetic counsellor. Taking an extreme view, if everyone received genetic advice before having children, at least some genetic disorders could be avoided entirely; but as Kessler points out, in our "free" society

people can be offered advice only on the potential hazards. This is both a psychological and a social issue, as is the need for counselling when infants with genetic defects are born.

It is the problem of communication that is the focus of Kessler's book—to help each affected family to understand the medical facts and to appreciate the way heredity works, while assessing their options. The initial chapters discuss general principles of genetic counselling and suggest how it can be integrated with established counselling practices, while the second section consists of eight chapters dealing with specific genetic disorders.

Each is written by a specialist in the field addressing the psychosocial issues raised, in their eyes, by specific genetic disorders.

The end product is a book that anyone working in medicine or medical social work should find both a good read and a text to be referred to time and again in the years ahead. It is not for the casual reader or for the average parent of an infant born with a genetic defect, who might be shaken by blunt confrontation with the medical facts (which is where the role of the genetic counsellor comes in). But it meets a real academic need and is strongly recommended for those "in the trade".

Mary Gribbin

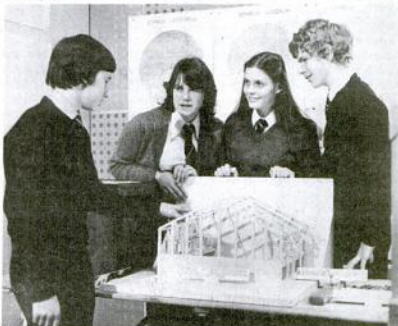
**Audience****Young scientist of the year**

BBC1, Sunday, 13 January, 1630h

Now that project work is part of most A-level courses, one might have expected the novelty of, and the enthusiasm for, the BBC's Young Scientist competition to be dropping off. Not so, as was clear to all from the first round of the 1980 competition. The three school projects were excellent examples of what makes good science: a problem logically tackled, a research survey skilfully performed, and some exciting findings carefully interpreted.

The teams had chosen to explore the complexities of what makes people absent-minded, of designing an aerodynamic roof-rack for a car, and of studying British and invasive Australian barnacles around our shoreline. As it was, the four girls from Bexhill deservedly won the heat with their splendidly thought out and analysed survey of absent-mindedness.

As a well planned scientific study, the Poole barnacle project deserved higher marks than it achieved. Yet, to be fair, so should that of the heat-winners with their interesting results. The Bexhill girls found that people tend to forget their names just after they get up in the morning, at lunchtimes, and in the late afternoon. The three learned scientific judges were noticeably relieved that there was no hard evidence for the absent-minded professor syndrome



The Bryn Allyn entrants discuss their bumble bee project

(yet the survey was of 14 to 18-year olds...). They were impressed by the objective test that the girls had devised, which distinguishes between people who are absent-minded and those who are not. It is something that has hitherto eluded professional psychologists.

The Banbury boys did well with their novel aerofoil designs and they achieved notable improvements in fuel usage. Roof-laden cars achieved 28.5 miles per gallon with their mark 2 aerofoil compared with 25 mpg when it was not in use.

Over the next three weeks the heats include plenty of challenging projects—"programming" bumble bees for winter pollination duties, a linear induction motor, a cordless electric lamp, pro-

grammable theatre lighting, enzymes fixed to resin beads for water purification, and other ingenious projects on the periwinkle, bioengineering, alternative energy sources, and a music synthesiser. The grand final is to be recorded at Pebble Mill, Birmingham, on 26 January, for transmission on 10 February.

Certainly this is the year when the schools begin to show us all just how mundane computers and microprocessors really are.

Richard Fifield

**Nuclear power debate**

BBC1, 8 January, 2220h

The issues involved in the generation of nuclear power concern us all, and therefore its right that they should be fully aired. But they are also

deep, vexed and technical. Is an hour and a quarter of verbal tennis the best way to deal with them?

The answer, I am afraid, must be "no"—at least with Robin Day as chairman. This is a vital but horrendously difficult role. He had to be time-keeper, scorer, cox, referee and Stretford End all in one. When cutting through zero-content political platitudes Day can be superb, as, indeed, he occasionally demonstrated in this programme, but the arguments in the nuclear debate do have content, and do need to be developed. All too often he brashly chopped off replies before they had begun even to make sense, let alone effectively answer the question.

Day's scientific grasp was shown to be lacking. Too many misleading statements were let through unchallenged. Norman Lamont, the Under-Secretary of State for Energy, whose grasp is perhaps even less than Day's, was allowed to float through the programme without the smoke screen provided for him by his advisors ever once being penetrated: he was unchallenged even when he equated the lifetime of a radioactive isotope with its danger.

One good thing that emerged from this programme was that it revealed all the protagonists as human. Too often the anti-nukes come across as strident dogmatists, and the pro-nukes as unctuous time-servers. Here they were all revealed as people—even if their wars were not exposed.

Martin Goldman

# The natural world through a lens

A group of Oxford zoologists combined their scientific skills and creative imagination to form Oxford Scientific Films, an organisation that tackles photographic work usually considered to be impossible

**Catherine Caufield** is a freelance writer. A small group of ex-Oxford zoologists that works under the uninspiring name of Oxford Scientific

Films is producing some of the most dramatic and technically-advanced films in the world. With an amazing array of equipment that they have designed and built themselves, they can film life on the forest floor from an ant's point of view, send a spaceship hurtling through a series of exploding galaxies, and show a chicken embryo developing inside its shell.

Chris Parsons, executive producer of the BBC's spectacular *Life on Earth*, commissioned OSF to film some 200 different forms of primitive life for the first programmes in the series: "There are only about a dozen people in the world who can produce film of this kind to the standards we require. For single cell organisms, OSF, because of their technical innovations and biological knowledge, lead the world."

The beginnings of the group go back to 1959 when, as a 42-year-old lecturer in forest entomology at Oxford, Gerald Thompson decided to make a film about the alder wood-wasp, which he had been studying for the past five years.

Luckily he had no experience with film making. If he had he would probably have been discouraged by the immense technical difficulties in filming insects. Conventional equipment cannot cope with the problems of vibration and radiant heat which are exaggerated when filming in close-up. Professional film makers knew this and stayed well away. Most wildlife programmes at that time concentrated on large, exotic animals which were easier to film and which producers believed audiences preferred.

Thompson bought, and taught himself to operate, a Bolex camera and a pan-and-tilt head, and went on, tackling technical problems as they arose. "It was an advantage," he says, "not to know what was considered impossible." He secured his camera to a lead-filled column and his subject to a machine drill plate to reduce vibration, and he blocked out 95 per cent of the radiant heat (which can be fatal to a small creature or could cause the set to burst into flames) by shielding the lights with a special colourless glass.

By 1960 Thompson had completed a twenty-five minute film, arrestingly entitled *The Alder Woodwasp and Its Insect Enemies*; won first prize in the BBC Council for Nature Film Competition; and developed a strong taste for film making.

Two younger marine zoologists, Peter Parks and John Paling, helped by Sean Morris, an undergraduate reading biology, were encouraged by Thompson's work to make a film of their own using micro-photographic equipment designed and built by Parks, although none of the three had any previous experience with film. *Argulus the Fish-Louse* didn't break box office records, but it did bring together the five men, Parks, Paling, Morris, Gerald Thompson and his son David, who in 1968 made what some of their colleagues then regarded as a foolhardy decision to leave the university and become full-time natural history film makers. In 1973 these five were joined by two more Oxford zoologists, John Cooke, just returned from a stint as head of the spider department in New York's Museum of Natural History, and Ian Moar, a technician. These seven tremendously inventive and energetic individuals formed an equal partnership, with Gerald Thompson as something of a father figure, in which all decisions are made—often after a heated argument—by majority vote.



Technology enlisted in making images of nature

Relationships among the seven are remarkably good. They have to be, in a business that sometimes requires two men to be together around the clock for months at a time on an isolated Costa Rican beach or a remote island in the Indian Ocean. OSF's working structure is flexible. Members work alone or in groups, according to the technical requirements of the job, the individual interests of the partners, and restrictions of time and space.

Most of the OSF's work is commissioned, but if one or another partner comes up with a project of his own which he would like to pursue, the group may decide to go ahead with it on spec. One such project, now more than halfway through its seven year shooting schedule, is Sean Morris's fifty minute film on pollination. When it is shown—probably in 1981—viewers will be able to witness some of nature's most intricate and beautiful self-perpetuating mechanisms, some of which have never been seen before, others only by a few dedicated field workers.

Each of the seven partners has his own area of scientific expertise. Among them they cover freshwater zoology, spiders, small mammals, marine invertebrates, insects, fish, and birds. They also have a staff of 15, most with science backgrounds, including three stills photographers, four technicians, and two botanists in charge of the 50 000 colour transparency picture library.

What gives Oxford Scientific Films an edge, besides the range and depth of the group's scientific training, is its specialised equipment, all of which the partners designed and built themselves. According to John Cooke, "there are very few engineering tasks we can't undertake here in our own workshop, and there are very few pieces of equipment that come into the building and remain intact."

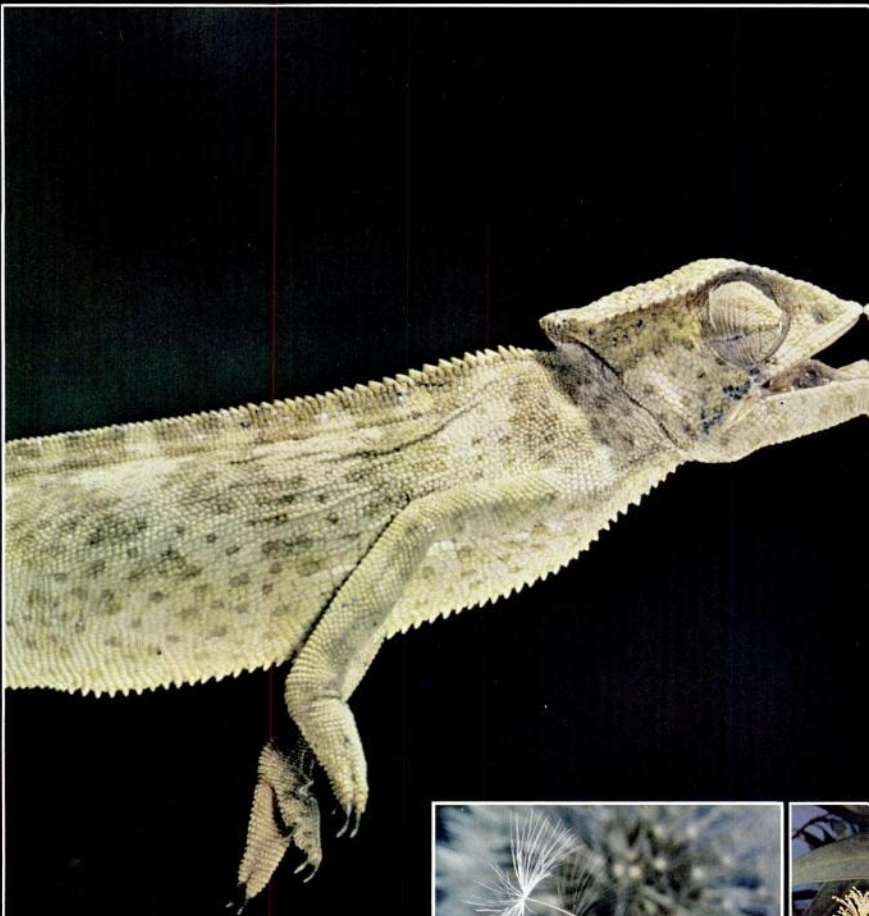
They protect this enormous investment of time and skill by strict secrecy. Nothing is patented because the necessary patent descriptions would reveal too much. Some of their professional rivals obviously feel that OSF's secrets are well worth knowing. One Japanese businessman who was given a tour of the premises took copious notes. "Sure enough," Cooke recalls, "about a year later we had a letter from his company asking for advice—one of their optical benches wasn't working as it should. Of course it didn't. We removed several essential pieces of hardware when we knew he was coming with his sketchpad."

The chief mechanical genius on the premises is Peter Parks. "I regard Peter Parks as an outstanding technical innovator," says Chris Parsons. Parks designed the first



*Bat feeds on a century plant. The animal can survive on only the pollen and nectar from this plant and is the plant's chief pollinator*

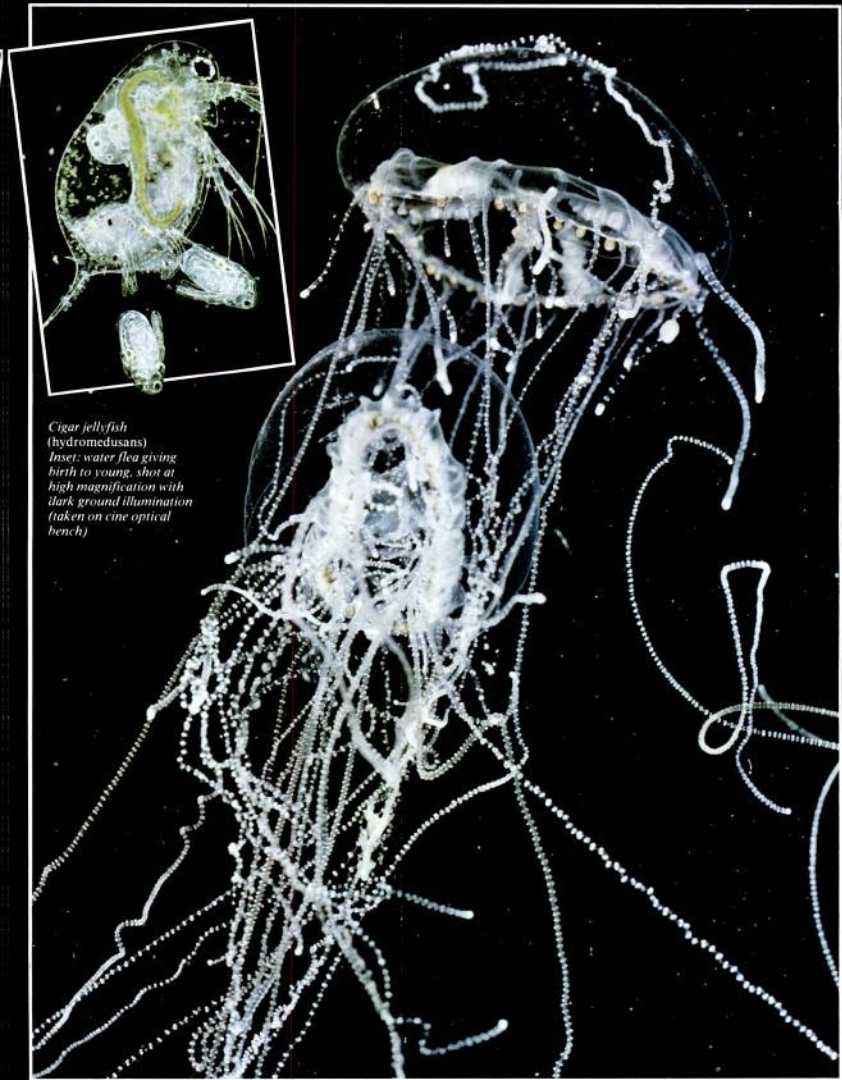








*A chameleon knocks a  
 gatekeeper butterfly off a  
 blackberry  
 Inset, left: dandelion seed,  
 with pappus  
 Middle: honey possum on  
 coral gum  
 Right: wasp attempting to  
 copulate with a slipper  
 orchid*



*Cigar jellyfish  
(hydromedusans)*

*Inset: water flea giving  
birth to young, shot at  
high magnification with  
dark ground illumination  
(taken on cine optical  
bench)*



optical bench specifically intended to extend the technical possibilities in macro-photography. By mounting camera and subject on a very solid bench so that, because any vibration was common to both, there appeared to be no movement at all, Parks made it possible to achieve much greater magnifications than before. He also introduced sensitive controls so that the camera could track, at very close range, the subject in three planes. Lastly, Parks incorporated in the optical bench a variety of subtle lighting effects which vastly increased the camera's ability to "see" very small objects.

One of OSF's most versatile toys is a camera which can shoot a close-up of one object while keeping in focus background objects as far as thirty or forty feet away. Thus, two or three focal planes can be accommodated in camera composite shots, making possible all sorts of special effects of scale. OSF also have a periscope camera which shoots parallel to the ground, one eighth of an inch from floor level, giving an insect's eye view of the world.

Other devices, variously named TumbleScope, Astro-probe, Galactoscope, and Cosmoglide, offer refinements such as 360° vertical tracking, wide-angle images through a 1mm gap, and something described as a "universal, multi-axial, video-mounted, barrel-rolling, yawing, tilting, rotating snorkel system."

Developed for biological filming, these devices have also proved attractive to commercial film makers, particularly for science fiction movies, which helps to explain their rather bizarre names. The camera which can shoot through a pinhole to give a wide angle view of a bee pollinating a foxglove is equally effective in making a spaceship seem to fly through a time warp. Tiny marine invertebrates magnified hundreds of times turn into throbbing translucent monsters. *Superman*, *The Hellstrom Chronicle*, *Alien*, *Flash Gordon*, and Ken Russell's forthcoming *Altered States* all have OSF special effects, from giant bees to exploding galaxies.

Although they have branched out into science fiction, television commercials, and books, natural history films are the group's first love and still their major concern. Most of their work has been for television, including thirty programmes for Anglia's *Survival* series; specialist sequences for the BBC's *Life on Earth*, *The Body in Question*, *World About Us* and *Horizon*; and programmes for Australian, Canadian and American networks. Their *The Making of a Natural History Film* (1973) received an Emmy, the Prix Italia, and the Society of Motion Picture and Television Engineers award for Best British Documentary.

OSF's headquarters is a box-like single storey building made of Cotswold stone, set in quiet woodlands nine miles from Oxford. Gerald Thompson's house is next door and Blenheim Palace just behind. Inside is a collection of offices and studios covering 10 000 square feet. The atmosphere is informal: visitors and staff lunch together at a long wooden table. They're a clean-living lot out there in the Oxfordshire countryside: lunch (brown bread and cheese) is followed by a brisk game of badminton: one partner keeps fit by wearing four pound iron weights on his feet: and when I was there on a cold November day two of the men were wearing running shorts.

Although all seven have abandoned their academic careers, there are discoveries to be made from behind a camera. The essence of OSF's work is observation: waiting and watching. It's not as relaxing as it may sound. In order to film the pollination of the hammer orchid (*Drakaea elastica*), Sean Morris and Gerald Thompson went to Western Australia and kept a vigil, each with two cameras trained on two different flowers, for twelve hours a day, every day for six weeks, waiting for a male thynnid wasp to appear. The wasp sometimes, not always, mistakes the flower of the hammer orchid for a female wasp and

tries to copulate with it, an action which results in the hinged stalk throwing the wasp onto the ripe pollinia which adhere to his head and enable him to pollinate the next hammer orchid he finds. The whole process is over in seconds so Morris and Thompson had to be on the alert always. Six weeks waiting and an outlay of £10 000 resulted in three minutes of fascinating film.

These long waits, however, provide ample opportunity for the trained observer to take note of unusual behaviour. John Cooke, lying in wait by a river to film something else, discovered, while watching a raft spider hunting on the surface of the water, something no arachnologist had noticed before. The spider, by putting the tip of his foot into the water and vibrating it, was able to attract fish to him which he then caught and ate. This vibrating attraction mechanism had never been described.

On another occasion Paling, Cooke and David Thompson attempted, for a programme on the natural history of Buckingham Palace Gardens, to film perch spawning, an act which lasts only five to ten seconds and is therefore not easy to capture. They took turns watching the fish in a tank until, after several weeks, "we could predict with certainty which fish was going to spawn when. We just began to think like the fish themselves after all that time with them," John Cooke remarked. Only one other person had ever seen perch spawning before, and the OSF team's film is the only record of the act.

Discoveries made in the course of filming are recorded, of course, not in the pages of a learned journal, but on celluloid. Do the group ever regret having chosen to leave academic life? Gerald Thompson got a faraway look in his eyes when I asked him that question. "There were at least three doctorates in the woodwasp film," he said. "I have masses of unpublished papers. I used to wonder about it, but our films are seen widely in schools and by the public. I think that's just as, perhaps more, important. I'm not worried about publishing now."

### Work in the woods

Members of the group are not always to be found flying off to film in exotic locations. A great deal of work can—indeed must—be done in the OSF studios and the surrounding woodlands. Here again their scientific training is of immense value as it enables them to create in the studio the conditions under which the action they want to film can take place. They have elaborate equipment to help duplicate natural conditions, including temperature, humidity and light controls, and a 1700 gallon water tank for underwater filming which can duplicate any conditions from those of a still pond to a raging mountain stream, with appropriate geology, vegetation and marine life. Even so, animal behaviour is unpredictable and salmon may refuse to spawn or butterflies to pupate.

There is usually a certain amount of animal life on the premises, although the population is transient. Current residents include a python, a snapping alligator turtle, a tarantula, locusts, rabbits and foxes. Outside, next to a specially constructed fox sett which has a peephole for filming, is a magnificent 400 year old dead oak tree, late of Blenheim Palace ("we borrowed it from the Duke of Marlborough"), whose hollows provide shelter for an assortment of wild creatures.

It all seems very idyllic, but it's not an easy business: crawling through the jungle, waiting weeks for a single shot, climbing a mountain with 75 pounds of irreplaceable camera equipment on your back—and worse dangers can lurk back at the studios: while I was there I overheard one of the partners telephoning a supplier, "I know he said he'd sent them, but we haven't had them yet. Yes, well they may turn up. We'll wait and see." As he hung up the phone he remarked to no one in particular, "They're quite poisonous scorpions, too, actually." □

# Feedback

## We won't be fooled again

Sidgwick and Jackson, enterprising publishers who foisted on an ungrateful world *The Sirius Mystery* (a rambling account of alleged contact between the ancient Egyptians and folk from nearby star Sirius), has done it again. We reproduce here the picture that is included, poster big, in its latest epic, *The UFO Phenomenon* by Johannes von Buttlar.

The picture is not captioned, except to say that it was taken by the astronauts on board Gemini 7 in 1965. A reasonable reader, given the title of the book, might be forgiven for assuming that the two white blobs at the bottom of the picture are real UFOs.

Alas, no. Sidgwick and Jackson has fallen for one of the

best-known hoax pictures in ufology. As James Oberg (winner of the *New Scientist/Cutty Sark* UFO essay contest) pointed out way back in 1976, the original photograph—NASA catalogue number S65-63722—shows the nose of the Gemini capsule silhouetted against the Earth. The UFOs are reflections of sunlight from two bits of hardware on the outside of the craft. An unknown forger retouched the photo to make the spacecraft's nose blend into the dark background of the Earth, leaving the two reflections suspended mysteriously in space.

Oberg commented: "It is the desperation of some outsider trying to manufacture counterfeit 'astronaut UFO' evidence, an activity which should not

The computers in Vietnam were programmed to convert automatically the geographical coordinates of locations wasted in Cambodia to those of locations in Vietnam, which could be wasted "legitimately". Mag tapes containing the doctored data were then sent to the boys at the Pentagon as if they were records of actual legit bombing operations.

Unlike Nixon's amateur clean-up, which was relatively easy to spot, the dirty computer tapes were read as Gospel truth. The Ministry of Untruth is but a chip away. □

## Rogers repents—almost

Further to our shock exposé last week of the carry on at the Royal Institution's Christmas lectures, we watched the final lecture eagerly. It was the only lecture still to be given after we asked about Eric Rogers's not very exemplary laboratory practice. What we saw astonished us, and did little to allay our fears.

Rogers managed several rambling minutes of "safety warnings", which consisted largely of admonitions to his young viewers not to try his tricks at home. That was not our point; we don't object to the tricks, we object to the way he did them, and he didn't mention that. What was worse, shortly after this off-the-point warning, Rogers was weaving about dangerously close to a pretty red laser beam. How on earth are we to convince people of the real danger of these and other devices when they see "experts" ignore all safety precautions. □



be necessary if the 'real' UFO evidence were as persuasive as many think." Better luck next time. □



If anyone at the Genetic Manipulation Advisory Group would like to know where we got our photograph of a category IV containment unit, he or she should send a sizeable bribe forthwith. □

## Bad news for good news

A super press release has come our way. It tells us that a major IBM user, Rowntree Mackintosh, has bought some things called SyFA distributed processing systems to provide its depots "with more powerful local processing capability and a degree of independence".

The £1.2 million system will enable Rowntrees to speed its mouth-watering delicacies around the country in a near-optimal fashion. To mark the occasion the PR people for the companies concerned sent us a half pound of lovely Good News chocs. But they reckoned without the good old Post Office—there is something rather off-putting about a sticky smear of tangerine cream and toffee bisquette that quite stifles the appetite, even for free chocs. □

## Light work

If you venture into the little village of Pershore, near Gloucester, and ask residents what attractions the place has to boast, the answer could well come back: "We have the biggest dark shed in the world." What's a dark shed? In Pershore's case, it is a huge redundant aircraft hangar on what used to be the village's airfield, closed down a few years ago.

The nearby Royal Signals and Radar Establishment commandeered the building and spent £100 000 to equip it with 3000 tungsten lamps. Between these, these lamps can simulate any stage of darkness between pitch black and twilight. The RSRE's boffins can set any one of an amazing one million levels of illumination with the lighting system.

Pershore's dark shed is just over half a hectare, a bit smaller than a football pitch. This beats other installations in the US which might have rivalled it as the world's biggest.

And the shed's purpose? The RSRE says that it is for testing the latest image intensifiers that help soldiers see at night. However, it has been suggested that the shed would be a wonderful venue for rock concerts or indoor sporting events. The building's cost-conscious owners could well consider letting it out for these purposes once the next round of defence cuts come along. □

## Headline news

Heartfelt thanks to all who offered to enlighten the office ignoramus who couldn't understand the headlines, especially to the gent who thought it so urgent that he telexed us. The most popular answers were that the larcenous canal engineer was William Smith and the German physicist was Werner Heisenberg. Leonardo da Vinci was runner-up for the canal engineer and Albert himself for the physicist. But we still don't really understand the canal headline, and while we can see the gypsy's point, we aren't certain about Heisenberg either. But we did like Phillip Bage's suggestion that the gypsy might alter the future in the very act of foretelling it. Further enlightenment would be welcomed, but only to tell us the great moment of science involved, rather than the protagonists. □

## Lying bits

Truth, as Henry Kissinger would say, is a gongblasted business. Proof of his wisdom comes in a revelation that even that guardian of "objective truth"—the computer—has been caught lying about secret bombings of what was then Cambodia. It all happened a long time ago, and it happened like this.

US Air Force computers in Vietnam had the task of recording all sorties flown. Details of the flights were then supposed to be transmitted to the boss computers back at the Pentagon. But, according to Admiral Moorer, who was chairman of the Joint Chiefs of Staff at the time, the computers in the field systematically lied to the Pentagon computers, using the same explosive-deleted medium as Richard Nixon—magnetic tapes.

THEY GOT THE COMPUTER FROM THE PENTAGON





# Forum

## A GROUNDLING'S NOTEBOOK

### Spare the rod

Donald Gould



Amidst all the demands for a reintroduction of The Rope, and of flogging, and of "short, sharp tastes of discipline", and various similar Islamic sanctions, I was delighted to see a brief news item in the *Daily Telegraph* a week or so ago headed "Ticking off cuts repeated teenage crime". This was the label to a report from "Our Crime Staff" which revealed that an "experiment" started last July in the Alder-shot area had demonstrated that, by and large, "cautioned youngsters", who had been given a severe verbal wiggling, in the presence of their parents, for some relatively venial sin, were "unlikely to come to police notice again".

When I was about seven or eight years old I went (and I remember the event in vivid colours—almost in terms of the touches and tremours involved) to a building site with a pal. Among the many fascinating items which were there for our delight was a steam traction engine, and a hundred foot run of rubber hose.

It was a Saturday, and there were no workers around.

We had a go at the traction engine, but lacked both the skill and the strength needed to do it any damage. The hose was easier prey. I had a pen-knife, almost new, so still sharp, and we managed to slit the whole of that hose, from end to end. It was hard work. Why we did it, I have no idea. But we did it, and went home filled with a sense of achievement.

Nobody, except our two small selves, ever knew what had happened (or, at least, that we had been involved in what had happened), and so there was no kick-back from the event, so far as we were concerned, and it was simply a matter to be nursed or forgotten within the confines of our own two tiny minds (and you will note from this essay that one of those tiny minds is still nursing and not forgetting the event).

Many years later, at the age of 12 or so (years were long and wonderful in those days), and having, by then, doubled my experience of life, I became involved in yet another criminal activity. I had gone up the line (a sixpenny train fare in those good times) to spend the day with my best friend, who had lived alongside me, near The Manse, in Watford, and who had since moved to a grander home in Berkhamsted. Come eventide, and the need to go home, he had gone with me to the station. With minutes to spare (and, just like the years, how wonderfully long were the minutes in those golden times of yesterday), we wondered what to do while waiting for the train. To do nothing for a quarter-of-an-hour or so would have been a denial of the immense value of every passing moment of life.

I had a great idea. We went to the public telephone box in the station entrance hall, and I opened the directory, and put a finger-nail down and stabbed the name "Brock". Then I put twopence in the slot (two old pennies, mark you—so it wasn't that extravagant), and, when a lady answered, I said "Beware! We are coming to steal your silver!" And I hung up.

Thoroughly pleased with our jape, we went back to the platform to await the train. But in no time at all, and before the train arrived, two bulky figures appeared further down the platform. Although very young and very foolish, I was no kind of a fool, and I knew at once who and what they were, and I was right.

They were the cops.

They approached us.

"Have you been making a telephone call?" the larger of the two huge persons said. "No-No-No." I stuttered back, in short, frightened, and hardly manageable notes. "We have reason to believe that you have," said the larger of the two huge persons.

"In fact, we have a witness." And then I saw, skulking behind their bulk, the booking clerk, who had watched us in sour fashion as we had giggled and fussed around the phone box opposite his cabin.

I'd managed to choose from the telephone directory, quite by chance, the Brocks of firework fame, and they had, evidently, lots of silver, and were, evidently, sensitive to the risk of robbers. How they also managed to direct the police in no time at all to the desperadoes threatening their wealth is something I have never discovered. Perhaps that booking clerk had something to do with it—God rest his soul.

Anyhow, we were hauled off, and we were sat down in front of an Inspector (he might even have been a Superintendent) at Berkhamsted police station, and he tore us off a strip or two, I can tell you. He said he knew both our fathers, and would be having a chat with them, and he asked me what I proposed to do with my life. When I told him I wanted to be a doctor, he said "What, you! A doctor! What kind of doctor do you think you'd make?" Then he sent us home.

Oh, I was ashamed. For months afterwards, every time I saw a Bobby, I was sure he knew all about me, and I tried to skulk by on the other side of the street.

And ever since that frightful ticking off, I've made damned sure that my crimes have been so organised as to remain undiscovered, and have thus ensured that I was "unlikely to come to police notice again". □

## MEDIA MESSAGES

### Tell us a story

Tim Robinson

There is a maxim within the bewildering complexity of the media which goes before all others: keep it simple.

It might be of scholarly interest to trace this injunction back (an imaginative guess) to the telegraph as an instrument for the transmission of scoop and scandal over long distances when the chances of distortion (other than the commonplace and intentional) were higher than they are today. Or maybe it is that reporters are simple folk themselves whose passion for uncovering the reality of living is second only to their desire to classify everything.

But even scientists, to take the classifiers *par excellence* of the 20th century, exhibit nothing like the same intensity of effort when it comes to the reductionism common to journalistic expression. And I would be churlish and foolish to insist that anything like all my colleagues took simplicity as an expedient for reality.

Reporters tend to blame such simplification on that mystical breed known to insiders as "subs", held by many a leg man to be congenitally opposed to literary composition other than of the "Princess in shock mercy dash to sex-change vicar" variety. Nevertheless, it is often reporters who fail to deliver copy which accurately mirrors the story they purportedly tell. The story: now maybe there is a clue, redolent as it is of literature, of fiction. It suggests instantly a beginning, a middle, an end. If only "events" could be so easily dealt with, even by those numbers of journalists who are writing or about to write a novel.

One could argue that the complexities of life today—down to the most mundane, like trying to get a mortgage—defy all imaginations except the truly literary: the eye of the great novelist. One of the most graphic accounts of the Napoleonic advance into Russia is provided by Tolstoy. Today, the novel's role has been largely taken over by film. If we take a recent complex "great" event, almost totally misreported at the time—the Vietnam War—we may find more truth by seeing *The Deer-hunter* or *Apocalypse Now* than by reading any number of news stories of the time.

1980 is just 20 years on from the beginning of the fateful increases in "advisers" ordered by Jack Kennedy. It was this surreptitious involvement designed to obscure just what the US was doing in South-East Asia which kept media uncertainty high in the early 1960s. The day-by-day business of filling the pages meant no one bothered much to take a longer, more informed look. Filling pages also meant reporters looked for quick and

# Forum

continued



easy sources, the endless useless bumph governments anywhere are delighted to provide.

When the war proper broke out, the lack of any perspective by the media helped to compound their reliance on official help and direction. Also, it might have looked very liberal of the Pentagon to forbear from overt censorship; subsequently when things began to go badly wrong, the generals were able to blame the media for losing them the war.

Such a charge is nonsense, but it is true that during a critical phase—the Tet offensive in early 1968—the media spent all their time suggesting the North was winning when it was actually losing. Indeed the negotiations which started later that year were a response by Hanoi to its setbacks. Tet was reported badly because the reporters in Saigon were so out of touch with an extremely complex situation. When the Vietcong attacked Saigon itself, albeit in small groups, newsmen were confronted with a war they had previously seen separated from themselves: it helped to “prove” the North was winning. At the same time the US government had been proclaiming how close to success it was: from this point on the media took the line they had been betrayed (they had, by their own susceptibility to official pronouncement), and discounted anything Washington said. Worse than believing nothing Washington might say, reporters took to making their own instantaneous judgements on the ground—all of which proved equally suspect but which, because they were seen on television, reinforced a false picture of what was happening.

It will be many years before a “true” assessment of what Vietnam was about will be available. Meanwhile we need to know as much as possible in order not to make the same mistakes again. I venture to suggest that those mirrors of reality, the press and broadcasting, may not have the capacity to tell us much more than scattered anecdotes. The real and urgent need is for some meaning, some coherence.

If the two most recent films on the war, *The Deerhunter* and *Apocalypse Now*, can be mentioned yet again I think we have the answer. What has intrigued me is that neither film is anti-war—or anything remotely approaching it. Much more to the fore is an attack on the failure of political will or direction. *The Deerhunter* especially loads our sentiments against the exploitation of genuine patriotism which is shown to have been betrayed by vacillation and indifference by government, wasting (in both senses) such a valuable national asset.

*Apocalypse Now* demonstrates in the first part a similar failure, this time by showing the effects of misdirection—or no direction at all—from the top. The ending surely shows where such failures lead: back to mindless tribalism. No other medium could have handled such profound concerns without parodying them, thus weakening their impact and the importance of their themes. □

## OPINION

### To market, to market?

John Burton

The thinking conservationist is often presented with dilemmas. Is it right to fly half way round the world to a conference? This and many other similar insolubles can provide endless debate. One of the first of such dilemmas presented itself many years ago when I was working with Friends of the Earth. After a hard day trying to save the world, we had adjourned to the

local for a pint or two, and the conversation drifted round to agriculture, land use and self sufficiency. Britain, we were all convinced, should be more self-sufficient—why turn prime agricultural land over to fattening dairy cattle? Then came the realisation—how much of Britain is devoted to sugar beet, barley and hops... oh well, it's always best to leave a bit of the world to save tomorrow.

The standing joke at most international conservation conferences is the number of trees that have to be cut down to provide the paper for the conference trying to save them. But perhaps an even bigger problem, though rarely discussed (even between consenting adult conservationists) is how conservation money is raised. There are many, many methods, most of them open to some form of criticism. For example, many charities have investments—and may even have shares in the oil companies producing the pollution they are fighting against. The most difficult problem of all is the trading and promotions engaged in by some of the larger wildlife charities. Although most exert some sort of quality control, the one aspect they never seem to have considered is that by merely engaging in promotions they are in fact encouraging what is perhaps the most serious environmental problem confronting us today—the expansionist exploitative economies of the developed world.

Not only are they encouraging people to eat over-packaged energy intensive crisps, drink from disposable cups or place their drinks on plastic laminated coasters, but by promoting luxury goods they are contributing to the ever more disastrous spiral. A glance at the Christmas brochures of any of the wildlife charities will show what I mean—conspicuous consumption is rife. The promotion of petro-chemical based products is rife. (In case anyone should think I am criticising organisations other than the Fauna Preservation Society—I would emphasise that most of the above can be levelled at the FPS as much as the Royal Society for the Protection of Birds, the World Wildlife Fund and all the others—it's only a question of scale.)

The difficulty is that as soon as an organisation starts to become successful, it starts to think big—either in terms of membership or fund raising. The normal progression is then to call in a professional organiser, fund raiser or administrator. Very laudable—I'm a great believer in professionalism. But not only do these professionals often expect salaries at a level comparable with top industrial salaries, but far more important, they bring into the organisation all the classic marketing and economic approaches. So the dilemma exists; advertising and mass “marketing” are essential if conservationists are to communicate, and if we continue to operate in a free enterprise system we need to raise funds. But the advertising, as the main prop to conspicuous consumption, I believe to be the greatest, yet most insidious environmental evil. □

## WASHINGTON VIEW

### Political population explosion

Dan Greenberg



We hear that the mother of parliaments is reconsidering its tradition of light staffing and scant amenities and may provide a corps of personal assistants and office space for each of its members. The case for some staff assistance for a modern legislative body is so obvious that it need not be stated. What must be observed from our own congressional experience, however, is that there is no such thing as just a bit of staffing, for it is

in the nature of staff to generate the need for still more staff. And, given the fact that the legislatures, yours and ours, are



sovereign in their own housekeeping affairs, there is nothing to prevent this proliferation.

An account of what's been happening to the population of Capitol Hill in recent times was provided not too long ago by *Congressional Quarterly*, an authoritative, privately published weekly (despite its name) that systematically reports on the Congress and other parts of the US government. By the latest count, our 100 senators and 435 representatives are served, directly or indirectly, by over 38 000 employees, ranging from policemen in the parking lots to \$50 000-a-year legislative assistants. The total annual bill for running the US Congress is \$1.2 thousand million, and going up. It may be argued that the parking lot cops, printers, barbers, messengers, and other run-of-the-mill employees on the congressional payroll really are incidental to the Congress and do not constitute evidence of swollen staff. But putting them aside, the girth as well as the recent growth of Congress's committee and office staffs are extraordinary. In all, these staff members now total nearly 20 000—to serve, it should be recalled, 535 Congressmen and women.



But that's not all, for in addition to the staffers who serve in the personal offices of the members (house members are allowed a maximum of 18; Senate office staffs vary by state population), and the staffers who are attached to committees, the Congress has also equipped itself with several "think-tank"-style and investigative organisations that are there to serve any and all members and committees. There's the General Accounting Office, which, with 5200 employees and a budget of over \$200 million a year, conducts investigations for the Congress. The congressional research office, part of the library of Congress, has a staff of 850 to answer big and little inquiries from the membership. The Office of Technology Assessment, with 130 employees and \$11 million a year—lots of it to hire outside experts—is another congressional servant, as is the congressional budget office, with 220 employees and a budget of \$12 million.

With the budget of the US government now over \$500 thousand million a year, the relatively small fraction spent on the legislative third of this enterprise might possibly be a bargain, given the fact that the Congress serves as a balance against the executive branch and therefore ought to be equipped for the task of devising sound programmes, crimping waste, and so forth. Such creditable activities do, in fact, occur on Capitol Hill. Lots of good ideas come out of the Congress, and many undesirable activities get flagged by Congress: furthermore, the growth of government spending in recent years has been so extraordinary that Congress has had to take on additional help just to keep up with what's going on, let alone working its way through the wiles of Lyndon Johnson and Richard Nixon.

Nonetheless, once that bright side of the coin is acknowledged, what must also be noted about the population explosion on Capitol Hill is that a lot of it serves no purpose but the glorification and re-election of the membership. In this big, busy and noisy country it can be difficult to attract national attention—for which almost all members hunger. It is even difficult to gain the notice of the folks back home who sent them to Washington. An abundance of staff, however, can be a great help in gaining national or local notice, especially if it's a clever staff.

The object, of course, is to create the impression—preferably based on reality, though illusion will do, if necessary, which it often is—that one's congressional employer is active and effective in the affairs of this nation. In pursuit of this image, the inhabitants of Capitol Hill put forth incessant barrages of press releases, reports, and various papers of one sort or another, all

designed to impress upon the citizenry the belief that the presumed originators of this documentation (it's all in the name of the elected member, even if he or she, in fact, had nothing to do with it directly) is a powerful force in the affairs of the nation. Thus, with an alert staff, even the most legislatively unimaginative legislator can get attached to newly introduced bills, and pass himself off as a shaker and mover. Legislators to whom no one listens for legislative guidance can create the illusion back home that they're in thick of national politics by responding, on TV or in print, to presidential statements or exciting news developments. Staff is the key to it all—plenty of staff being necessary to play this game, and plenty plus to keep up with the staffs of the other 534 competitors for attention.

It may well be that in the biology of legislative bodies, there is no such thing as a little staff. □

## JOKING ASIDE Plus ça change

John Gribbin

Astute readers will notice that the title of this column has been changed. This effort to turn over a new leaf and cast aside childish things (appropriate, perhaps, at this forward-looking time of year) is actually made largely for the benefit of less astute readers, who had failed to notice that the appearance of the column runs on a precise 28-day cycle, and had thought that the term "lunatic fringe" referred in some derogatory sense to them. Nothing could be further from the truth, and in order to placate the multitude I have resolved henceforth to follow a steadfast path of sober and honest reporting, setting joking aside. And to that end, I am happy to start the new year with an imaginative and forward-looking scientific proposal (actually technological, but who's quibbling?) for the creation of what can only adequately be described as a genuine lunatic fringe.

The proposal has the brilliant simplicity of all really good ideas, and hinges on a piece of scientific observation as obvious as what'sisname's study of the boiling kettle. Shooting a rocket up to an altitude of a few hundred kilometres requires much less energy than putting the same mass into orbit at the same altitude—for a 275 km altitude (corresponding to a 90 minute orbit) the ratio is 1:12, so that it is very easy and cheap, with present rocket technology, to place packages 275 km above the ground, as long as you don't mind them falling straight back down on your head. In two articles spread over the November and December issues of *Analog* magazine, plus a fictional story in the December issue drawing on this factual base, Roger Arnold and Donald Kingsbury have followed up this obvious observation with a logical proposal to take advantage of this aspect of the laws of physics.

For present day orbital activities with manned vehicles, the situation is even worse than the 1:12 ratio mentioned above, for to bring your daring astronauts back from orbit you have to use even more energy to break their vehicle's orbit. Indeed, the energy of the returning spacecraft is, more or less, balancing the extra energy put in to the rising spacecraft to make it stay in orbit, and if we had a 275-km high bucket lift on an endless loop it should be easy for the astronauts to step off at the top onto a conveniently passing satellite, each being replaced by a similar mass being passed from the satellite to the lift. Of

IT'S A PIE IN THE SKY, 150KM LONG



## Forum

continued

course, we don't have a 275-km high lift. But that, in a nutshell, is the basis of the Arnold-Kingsbury proposal.

Instead of a lift, they envisage a stream of vehicles which they call lighters, rising from the Earth to rendezvous with a satellite space-station in the 90 minute orbit as it whizzes overhead. To catch such a lighter at the top of its up-and-down trajectory, they suggest equipping the space-station with powerful magnetic fields which, depending on your point of view, either speed the lighter up to the satellite's orbital velocity, or slow it down to rest gently on the space-station's landing deck. Of course, this means that the station gives some of its momentum to the lighter, and so sinks a little lower in its orbit. But that can be exactly balanced by ejecting another lighter with just enough energy to cancel out its orbital motion so that it falls back to Earth!

The brilliant simplicity of the scheme is enhanced by looking at what happens if the space-station is used in a similar position to catch lighters from the Moon, full of raw materials, while sending lighters full of processed materials down to Earth. Because of the relative positions of the Moon and the satellite in the Earth's gravity well, this process actually gives a gain in energy to the space-station!

Mind you, the space station has to be pretty big. To be quite honest with you, it has to be 150-km long, massing more than 50 000 tonnes, and all built by conventional brute-force orbiting rockets like NASA's space shuttle. But according to Arnold and Kingsbury that would cost only seven thousand million dollars, which really doesn't look too bad compared with, say, the cost of Concorde or Britain's proposed nuclear power programme. This would really get all the orbiting power station schemes off the ground, with the bonus of virtually free energy from dropping moonrock down the potential well as the next stage. Last month, I brought you faster than light travel; next month, maybe antigravity. Meanwhile, seriously though folks, joking aside, how about cheap space travel and free energy forever? □

## WESTMINSTER SCENE

### So much for electric cars

Tam Dalyell MP



Lewis Carter Jones (Eccles) is a single-minded campaigner for the disabled, and in particular concerns himself with ways in which technology can be used for their benefit. He has inquired how far the Department of Energy has collaborated with the appropriate manufacturers in this country on the use of batteries in passenger vehicles, commercial vehicles and private cars. John Moore, Under-Secretary at the Department of Energy, pointed out

that the Department of Industry is responsible for coordinating government interest in electric vehicles and for sponsoring work in the manufacturing industry. Meanwhile the Department of Transport makes assessments of the part which electric vehicles of all types could play in the national transport network system. However, the Department of Energy maintains a close interest in all the above work.

At present, the savings in primary energy consumption resulting from the introduction of electric vehicles in place of internal combustion engine vehicles would be marginal. In the longer term, realistic figures for savings in oil resulting from the introduction of electric vehicles are difficult to estimate, since this would depend on the energy efficiency of the vehicles, the market penetration achieved by the individual vehicle types, and the future characteristics of the electricity generating system. Interestingly, Moore added that the Transport and Road Research Laboratory of the Department of Transport has calculated the energy efficiency of the various vehicle types. Comparisons of annual energy requirements based on these energy

efficiencies for cars and light goods vehicles in the year 2005, assuming 25 million vehicles covering 20 000 kilometres per year for each vehicle type (including indirect energy to manufacture the vehicles and batteries, and for heating) showed the advantages of the electric-powered vehicle to be slight. For example, today's car with natural crude oil-based fuel requires 74.6 million tonnes of oil equivalent (toe), while the same car incorporating energy conservation requires only 46 million toe. The advanced lead-acid battery vehicle would need as much as 80.4 million toe, the sodium sulphur battery vehicle 51.3 million toe. For anyone who sees the development of the electric vehicle as a panacea, these are indeed sobering statistics.

It is understandable that amid the announcement of David Howell's nuclear power "decisions", the culmination of one phase of the Rhodesia saga, and the Christmas scurry that affects the House of Commons as much as any office, that Neil Macfarlane's answer to my question on microelectronics went unremarked. I had asked education ministers what study they had made of the replies from local authorities, on their consultative paper for a microelectronics development programme in schools and colleges. Macfarlane replied that a careful study had been made, and that there was clearly a case for a programme to help schools and colleges make the best use of opportunities offered by microelectronics. However, he added that the announcement of firm plans for a programme remained dependent on wider public expenditure considerations.

When asked to what extent the programme had been affected by cuts, the minister replied that so far the programme had not been affected by any review of public expenditure. I must admit that many MPs were surprised to hear this, but Macfarlane's statement is accurate. He added that in the past six months he and Lady Young (the Minister of State at the Department of Education) had consulted the local authorities, and visited secondary schools and microelectronics manufacturers throughout the country to try to ascertain the pace of change. "The House will recognise that we have undertaken an important programme," the minister then went on. "We hope to make an announcement early in the New Year. By then we should know precisely what the level of expenditure should be, and how the taxpayers' money can be spent most beneficially."

The Welsh Nationalist MP, Dafydd Wigley, referred to the urgent need to give teachers and trainee teachers a background knowledge of microelectronics, so that in the next four or five years, pupils would be able to face this revolution. Macfarlane strongly agreed, and said that the important element of teacher training was under discussion. Ian Lloyd (Portsmouth), formerly one of the most active members of the Select Committee on Science and Technology, asked the government to accept that exceptions had to be made to the general strategy of cuts in public expenditure; although such exceptions should be few, the provision for microelectronics in schools should be one. Macfarlane said carefully that ministers did not underestimate the vital importance of the programme in the next few years. But one of their main anxieties is that in monitoring what has happened so far, they are not already obsolete in their ideas for the future. The pace of change has been tremendous in recent years, so they have to ensure that the programme is thoroughly up to date. Watch this space for further developments. □





# Letters

## Role of scientist

It may seem churlish for a scientist to raise an objection to Lord Todd's editorial of 3 January (p 2) about the role of scientists in the 1980s, but in one respect he seems to me to have suggested a significant weakening of the scientist's existing role. He discusses the injection of scientific information and advice into political decisions and says, rightly, that "if the scientist ... seeks to take political decisions himself he will lose his credibility".

Unfortunately, Lord Todd ignores the multitude of decisions that are neither political, in the sense of being made by government or elected representatives, nor scientific. These decisions are taken daily in public and business life and involve a mixture of science and judgement of the commercial and social factors which make up much of the art of business.

It is highly desirable that scientists should continue to be among the many individuals who take these decisions and that they should be encouraged to act in this way. It is also important that they should recognise that they are then going beyond their own specialised expertise and that they must not claim any special status. It is wrong to use a professorial chair as a soapbox.

In short, Lord Todd should be looking for greater participation by scientists in decision making, as well as for better ways of injecting scientific advice into the decision-making process.

H. J. Dunster London

## Polyrisk?

Dr Irvine Lerch ("Risk and fear", 3 January, p 8) makes an extremely misleading comparison between the risks of nuclear energy and smoking, because the hazards of cigarette smoke are self-imposed, but nuclear energy is equally a threat to pro- and anti-nuke alike. Perhaps this explains some of the "emotional intensity" which Dr Lerch finds so distressing, because many react quite strongly to having their lives placed at risk.

On the question of the magnitude of that risk, the only fact to emerge is the wide discrepancy in estimates, some of which originate in the work of the nuclear industry itself. We are, I assume, allowed only to admire the commitment of our political masters of the empirical method, as they attempt to discover the magnitude of the risk by the simple process of exposing us to it.

A. J. Lowry London

Feedback reported (22 November, p 627) on the phenomenon of lemon tea dissolving a polystyrene tea cup. This recalled a discovery I made some years ago of a possibly related effect. While peeling an orange, I happened to pick up a polystyrene cup, then found my fingertips (which were covered with "orange oil" from the peel) fairly well stuck to the cup. Being curious I applied a larger quantity of orange oil to the cup, and found that it would dissolve the plastic sufficiently to enable fine threads of dissolved plastic to

be drawn out.

After reading your article, I tried the same test with lemon oil, with much the same result. Probably oils from other citrus fruits may have the same solvent action. When Dr Michael Phillip, of University of Connecticut, added fresh squeezed lemon juice, I suspect that he also added lemon oil as a result of the squeezing action, which could explain his findings. Also the solvent action may well be accelerated by the elevated temperature of the hot tea.

It would appear to me that anyone who drinks whole citrus fruit juice (made from the whole fruit) from polystyrene cups faces a significant risk of ingesting dissolved polystyrene. If, as you state, polystyrene is a carcinogen in laboratory animals, it is disturbing to say the least. One wonders what other foodstuffs, apart from citrus fruit oils, may have a similar solvent action. Since "food grade" polystyrene is widely used in the food industry, it would be interesting to learn the considered opinion of the industry on this possible risk.

R. Cribb Waltham Abbey

## Boggle box books

Having just read "Young botanists beware!" (Feedback, 3 January, p 34) I am at one time amused and amazed to think that David Bellamy, co-author of *Botanic Action*, not only did not write the book, but also has not even read it, despite its having been published over a year ago. Putting aside the obviously irresponsible suggestions to boil leaves in caustic soda, for

which he cannot, I suppose, be directly blamed, I wonder just where this detachment might lead, or have led.

We all know Bellamy as the bouncing botanist, but is he? Is that cuddly popular image not just created for our entertainment by an actor appointed by Bellamy? Is the real Bellamy a seven-stone introvert? In fact, I wonder if Bellamy needs to exist at all. Wouldn't a TV producer with knowledge of botany be able to create the whole Bellamy industry.

My imagination is even causing me to ask who else might be not writing best-selling books, or appearing on the box? Are there other popular figures churning out programmes on zoology or astronomy for example, who are the creations of a production team? After all Magnus Pyke, Patrick Moore and David Bellamy are too good to be true aren't they? And what about Cyril Smith, Edward Heath, Enoch Powell and, of course, Maggie ...

Peter G. Hardy Bristol

## Hospital physics

I would like to clarify and correct a few statements in "Scanning for physicists" (This Week, 29 November, p 681) in case they may be misinterpreted. Training, education and the formation of a college/institute are all topics of current debate in the Hospital Physicists Association (HPA)—no decisions have been reached and it is certainly not the intention to ask the DHSS to take over the teaching and examining of hospital physicists.

## Grimbledon Down



Bill Tidy

# Letters

continued

No. 47

## - ENIGMA -

### Factory outing

Eric Emmet

I am the managing director of Our Factory and I write now from the wonderful Island of Imperfection.

I had better start by explaining about Our Factory. Over the years the personnel has doubled and although I do not like to boast I must say I am rather proud of that. At the start we had only four employees but now there are eight and I thought it would make a nice holiday if I took some of them to the Island of Imperfection.

At the time with which this story deals there were three tribes on the island—the Pukkas who always tell the truth, the Wotta-Woppas who never tell the truth and the Shilli-Shallas who make statements which are alternately true and false or false and true.

The three members of our factory with which this story deals were the Door-Opener, the Door-Shutter and the Door-Knob-Polisher. As is the custom of the island they were all made members of one of the three tribes, in fact each one to a different tribe.

They were pretty quick to understand how the tribes worked and I am glad to say they made no mistake in this puzzle.

Calling them A, B and C in no particular order they spoke as follows:

A 1.B is not a Shilli-Shalla. 2. C is the Door-Knob-Polisher. B 1.C is a Pukka. 2. A is the Door-Opener.

C 1.A is a Wotta-Woppa. 2. I am a Shilli-Shalla.

Find the tribes and the jobs of A, B and C.

A £5 book token will be awarded to the sender of the first correct solution opened on Wednesday, 23 January. Please send entries to Enigma No 47, New Scientist, King's Reach Tower, Stamford Street, London SE1 9LS. The Editor's decision is final. No correct solutions were received for Enigma No 45, Six Squares—Harder, the solution to which we published last week. Shame on you!

### Rising prices

Answer to Enigma 46

THURSDAY AND SATURDAY

For least cost the girls must be kept to short runs. He beat B on Sunday. So, you will find, he must have been first on Thursday and second on Saturday and Sunday. Two girls got 10p and the other (Alice) 16p.

Many departments including my own have as great an involvement in electronic instrumentation, physiological measurement, radiotherapy physics and radiation protection as they have in nuclear medicine and ultrasound. Diagnostic radiology has never specifically excluded physicists and the HPA has an active diagnostic radiology topic group.

Various aspects of biological or clinical engineering are also pursued in many departments.

Finally, in no way would I wish to detract from the magnificent achievement of Godfrey Hounsfield and the team at EMI in the development of computerised tomographical X-ray imaging.

P. A. Griffiths Lincoln

### Habitat protection

By chance your 6 December issue carried items on sand

lizards, forestry, and the Nature Conservancy Council (NCC) in Comment (p 754), This Week (p 756), and Monitor (p 775). The British Herpetological Society believes that the very structure of the NCC forms the common link in a situation needing governmental review.

Helen Jackson's conclusions on the plight of our northern sand lizard form a sad confirmation of our six-years' pressure on the NCC for adequate habitat protection at Merseyside, as yet unheeded. Two eroding stretches of frontal dunes represent the main surviving habitat yet they are still subject to an abuse now almost unique in coastal north-west Europe—that of unlimited public car access to their foreshore.

Despite advice from its Great Britain HQ, NCC's

north-west region (under direct control from England HQ) had first ignored then finally fled the problem. At the opportune moment of a new Coastal Strategy for Merseyside, it chose not to offend the local council responsible. It may be coincidence that Merseyside's Planning Officer has publicly supported this continued vehicular use, and also sits on NCC's Advisory Committee for England.

Keith Corbett

London

### Dowsing

"Dowsing works, that much is now certain" says Anthony Hopwood ("Dowsing, ley lines and the electromagnetic link", 20/27 December, p 948). This is incorrect. This certainly does not have near 100 per cent success and the most that should be claimed is that it is thought by some people that there is a mechanism, corresponding to the name, which seems to have been successful on some occasions.

Matters of this sort are settled only when the mechanism can be demonstrated on request. So long as it depends on unpredictable personal qualities it is suspect. It is quite ridiculous to suggest that "the field" is where a test should be made. That comes later when it has been made clear that there is a procedure which works to order by a mechanism which is understood in the sense of being demonstrable in the laboratory with only the necessary conditions present the removal of any one of which would upset the act.

We've heard it all before; indeed you said only a very few months back that telepathy was now a proven fact. Really you should be more careful. Until a mechanism has been reduced to the level of laboratory demonstration, or is directly deducible from such knowledge it is certainly not certain, and except in a

IT'S A DEVICE TO DETECT GULLIBILITY



gambling mood any sensible man would act as if it were not.

R. S. Scorer

London

My own experience in testing dowsers has shown that dowsing only "works" when the dowsers "knows the answer."

The case against dowsing is well put in the book *Water Witching USA* by Evon Z. Voigt and Ray Hyman (University of Chicago Press, 1959). Voigt and Hyman, an anthropologist and a psychologist, set out, with no axes to grind, to make a study of dowsing as a social phenomenon. But in the course of it (p 82) they concluded that dowsing was a pseudo-science: "We don't have to resort to prejudice to dismiss water witching as invalid. The evidence for it, when assembled and examined, is not merely insufficient according to current scientific standards (the same ones we would apply to 'acceptable' and plausible hypotheses). It is appallingly negative. We know few other hypotheses that have been put forth with such consistently negative experimental findings as the hypothesis that water witching 'works'."

The validity of Mr Hopwood's own experiments is suspect because they were not designed as "double blind". Denys Parsons London

When lecturing on parapsychology, I emphasise the need to distinguish methodologically sound research from appealing, but groundless, ideas. I sometimes illustrate this point by demonstrating dowsing.

I put a pitcher of water on the stage floor and walk slowly toward it, holding the same kind of dowsing rods that Anthony Hopwood describes. As I have announced to the audience, the rods swing together as I reach the water. I then step back and remark that my memory was faulty, you know how it is with absent-minded professors, and the "radiation" from water actually causes the rods to swing apart. I deliberately decide to believe this statement as I make it, and as I walk back toward the water, lo and behold, the rods swing apart! In both cases I do not deliberately move the rods, they just swing "by





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The Polytechnic offers positive support to staff wishing to attain further relevant qualifications and offers good conditions of service including sick pay, Pension scheme and 26 days annual leave.

Salary: on a scale from £5721-6550 which will increase on 1 April, 1980 to £5921-6566.

For further details and an application form please write (quoting ref 90/7) to the Staff Records Officer, City of London Polytechnic, 117/119 Houndsditch, London EC3A 7BU.

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**Qualifications:** Applicants should have a degree (or similar qualification) in engineering (or another relevant subject) and a good knowledge of Slavonic or Scandinavian languages; alternatively they should have a degree in modern languages and a sound background knowledge of engineering. The ability to write clear concise English is essential.

**Salary:** in the scale of £3591-42127 plus a compensatory allowance to offset personal contribution to superannuation. Starting salary according to qualifications and experience. Promotion to higher scales on merit.

**Application forms and full particulars from:**  
Executive Director,  
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Farnham House,  
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Closing date for applications: 18 February 1980



# Degree Finals this year?

## Your guide to our Milk Round

|                                |               |                                   |                   |
|--------------------------------|---------------|-----------------------------------|-------------------|
| Aberdeen (Robert Gordon's)     | 13th February | Leeds Polytechnic                 | 18th February     |
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| Aston University               | 31st January  | Leicester University              | 23rd January      |
| Bangor University              | 29th January  | Liverpool University              | 23rd January      |
| Bath University                | 26th February | London University (Gordon Square) | 12th March        |
| Belfast Polytechnic            | 12th February | Loughborough University           | 24th January      |
| Birmingham University          | 21st February | Manchester University             | 29th/30th January |
| Bradford University            | 11th February | Newcastle University              | 31st January      |
| Brighton Polytechnic           | 12th February | Nottingham University             | 25th January      |
| Bristol Polytechnic            | 4th February  | North Staffs Polytechnic          | 5th February      |
| Bristol University             | 31st January  | Oxford Polytechnic                | 6th February      |
| Cambridge University           | 31st January  | Oxford University                 | 5th February      |
| Cardiff University             | 22nd January  | Plymouth Polytechnic              | 19th February     |
| City University (London)       | 3rd March     | Portsmouth Polytechnic            | 18th February     |
| Cork University                | 15th February | Queen's University (Belfast)      | 30th January      |
| Dorset Institute (Bournemouth) | 12th February | Reading University                | 31st January      |
| Dublin University              | 13th February | Salford University                | 6th February      |
| East Anglia University         | 29th January  | Sheffield University              | 4th February      |
| Edinburgh University           | 22nd January  | Southampton University            | 29th February     |
| Essex University               | 28th January  | St. Andrews University            | 30th January      |
| Exeter University              | 10th March    | Stirling University               | 12th February     |
| Glasgow University             | 7th February  | Strathclyde University            | 8th February      |
| Hatfield Polytechnic           | 13th February | Surrey University                 | 6th February      |
| Heriot-Watt University         | 21st January  | Sussex University                 | 23rd January      |
| Huddersfield Polytechnic       | 21st January  | Swansea University                | 8th February      |
| Imperial College (London)      | 25th February | Ulster University                 | 14th February     |
| Kent University                | 25th January  | Wales Polytechnic                 | 23rd January      |
| Lancaster University           | 13th February | Warwick University                | 6th February      |
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# SCIENTISTS & ENGINEERS 1980 GRADUATES RESEARCH

The Scientific Civil Service provides a distinctive breadth of opportunities for scientists, ranging from the academic to the applied, in over 100 establishments, many enjoying unique facilities and international standing.

There is a strong emphasis on specialist training and career management which encourages the full development of individual potential, and opportunities to work in multi-disciplinary teams and for close co-operation with industry, universities and the armed services.

## Ministry of Defence

The Ministry of Defence employs approximately half the total number of scientists and engineers in the Science Group of the Civil Service. At present there are numerous vacancies across the broad range of scientific, technological and mathematical disciplines. These are located at over 20 different R&D Establishments mainly in Southern England.

To meet the ever-present demand for technical superiority in defence, scientists and engineers are involved in fundamental and applied R&D across the whole spectrum of equipment, systems and resources. They work on a comprehensive range of projects, at the forefront of present knowledge: microcircuitry, lasers, digital systems and microprocessors are just a few of the areas under investigation.

There are opportunities for liaison at an international level, and nationally with industry and universities – and with establishments throughout the UK, particularly good career prospects either in research or in project management.

Health physics is of increasing priority in MOD and there are a particularly large number of vacancies at present open to a wide range of physical scientists: specific qualifications and experience in health physics are not essential, and appropriate training is available.

## Government Communications Headquarters

In the continuous effort to solve the problems associated with development and implementation of improved radio and communication systems, government scientists and technologists, working at the Government Communications Headquarters in Cheltenham, have pioneered everything from electromagnetic propagation mechanisms and modulation techniques to novel radio receiving systems, including laser technology.

Training and career opportunities will allow recruits to become involved in a number of areas of GCHQ's work; there will also be opportunities for overseas contact and – in some cases – travel. Opportunities are for candidates with qualifications in physics, electronics, or related subjects. The majority of vacancies are for candidates with good honours degrees, but for some posts HNC/HND or other degrees are acceptable. Application forms from: Graduate Appointments Officer, GCHQ, Oakley, Priors Road, Cheltenham, GL52 5AJ. Ref. R: SA/22/FD.

## Home Office Forensic Science Service

The Forensic Science Service offers the prospect of highly advanced scientific investigation combined with the excitement and immediacy of criminal detection. Forensic Scientists assist the police – and ultimately the

process of justice – by analysis of subtle – but decisive – evidence in the most serious cases of crime. Eight laboratories are equipped with sophisticated instrumentation for use in the most advanced analysis techniques. In carrying out their task, scientists are often involved in visits to the scene of the crime, and giving evidence in court.

There are vacancies for chemists, biochemists, biologists, pharmacologists and materials scientists. Full encouragement will be given to obtain further qualifications. Good colour vision is essential.

## Police Scientific Development Branch

The branch adapts and develops new technology to meet the specific needs of the modern police force, and maintain a high level of operational efficiency. Working in small multi-disciplinary teams, staff are primarily concerned with two areas: exploring the use of computers as aids to police activities, and developing a wide range of sophisticated equipment – from electronic devices for detection of hidden objects to alarm systems.

## Scientific Advisory Branch

The branch provides a central advisory and research facility for the Home Office, dealing mainly with management, operational and equipment problems. Scientists work on a variety of research projects in the field of criminal justice.

## Operational Research

At government level, where decisions must be founded on more than economic criteria alone, the question of how best to allocate resources is extremely complex. In providing a rapid, flexible and highly effective method of evaluating alternatives, Operational Research has given a new dimension to decision making in government.

In terms of scope of work, and career development, the government OR service excels, providing scientists with the opportunity to become involved in problems of national importance. It is one area where ingenuity and a commonsense approach are as equally important as mathematical skills and a training in scientific method. Current major projects include logistics work for hospital support services, environmental resilience analysis and energy demand projection.

Openings for numerate scientists. There are opportunities to gain further qualifications, to MSc in OR.

## Department of Industry Warren Spring Laboratory

Based at Stevenage, this multi-disciplinary laboratory is a major centre for industrial and environmental research, providing a consultancy service for government departments, industry and local authorities.

The scope of the work is very broad – covering all aspects of industrial and environmental technology. Particular areas of interest include physical and chemical methods of mineral concentration and the control of industrial processes through microprocessors and the treatment of waste materials. There is a strong commitment to the evaluation of methods to control atmospheric pollution and oil pollution.

Extensive facilities are available for analysis work, engineering and process development – in fact all the services essential for advanced research in this very important area.

## Laboratory of the Government Chemist

The staff are mostly chemists, who do research on new methods or analysis and provide a wide variety of analytical and advisory services to government departments.

## National Engineering Laboratory

Applied research in mechanical engineering, partly sponsored by industry, is carried out here and developed in partnership with engineering firms. Opportunities for mechanical/electrical/electronics engineers.



## National Physical Laboratory

The laboratory has an international reputation for its expertise in metrology, and provides standards and precision methods of measurement over a wide range of physical quantities for industry, government and universities. It is also active in the fields of mathematics and its applications, computer science and materials.

Openings for physicists, mechanical/electrical engineers, computer scientists, mathematicians and materials scientists.

## National Maritime Institute

Founded in 1976 at Feltham, Middlesex, to carry out research in marine technology, with special emphasis on hydrodynamics. The work, much of it sponsored by industry, is concerned with ships, the off shore industry and engineering aerodynamics.

Opportunities for naval architects, mechanical/electronics engineers, aerodynamicists, nautical scientists.

## Meteorological Office

The Meteorological Office has made a major contribution towards the significant advances made in the accurate understanding and prediction of the weather and climate.

The development of new electronic instruments for automatic weather stations is a priority in conjunction with the integration of a highly complex telecommunications system with a major computer system. The current research programme includes numerical weather prediction, satellite meteorology, cloud physics and geophysical fluid dynamics. Opportunities exist to undertake studies in these and related areas, and to fulfill important research support and operational functions such as forecasting.

There are vacancies for physicists, meteorologists, computer scientists and electronics engineers.

**Qualifications:** Candidates, normally aged under 30, should have a good honours degree in a relevant subject for most posts but there are some vacancies where HNC/HND is acceptable.

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For further details and an application form for all posts other than those in GCHQ, (to be returned by 22 February 1980) write to Civil Service Commission, Alencon Link, Basingstoke, Hants, RG21 1JB, or telephone Basingstoke (0256) 68551

(answering service operates outside office hours).

Please quote Ref: SY/12/F/NO8.



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Application forms and Job Descriptions from Chief Environmental Health Officer, Civic Centre, Lampton Road, Hounslow TW3 4DN. Tel. 570 7728 ext. 3290. Closing date: 1 February, 1980.

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This is a three year post and the appointee will be registered for a CNAAP PhD degree under the supervision of Dr Roger Lindford, Reader in Chemistry. Duties will include six hours teaching per week. The project involves the construction of a novel calorimeter (77 to 1000 K) for studying the properties of solid electrolytes. Previous experience in solid state electrochemistry or calorimetry is not necessary. A good honours degree or equivalent in chemistry, materials science or a related subject required.

Commencing salary: £2915 plus £72 supplement p.a.

Application forms and further details from Staffing Officer, Leicester Polytechnic, PO Box 145, Leicester LE1 9BH. Informal enquiries to Roger Lindford, tel: (0533) 56151 ext 2202.

## ROBERTSON RESEARCH INTERNATIONAL LIMITED SEDIMENTARY GEOLOGISTS

Robertson Research International Limited have vacancies in their head office in North Wales for experienced sedimentary geologists. Applicants should be familiar with the full range of sedimentological techniques relevant to carbonates and/or clastics. The position is challenging with career prospects, and will require a successful candidate to work on individual assignments as a member of a team. Work is concerned with the study and interpretation of rocks from oil prospective areas. Preparation of technical reports is an integral part of the duties and experience in this field is required. Salary will be competitive and negotiable depending on age, experience and qualifications. The position is permanent and pensionable. The closing date for completed application forms is 28 February, 1980.

Please apply, quoting Reference P/13-2, to: Janet Hadgson, Robertson Research International Limited, Tŷ-y-n-Coed, Llanrhos, Llandudno LL50 1SA, Gwynedd, North Wales.



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We need development scientists to work in one or more of the following areas: Development of new components for domestic gas appliances, heating systems and novel accessories to metering equipment; design, development and field testing of new pipework and joining materials; assessment of improved flue gas disposal techniques; provision of technical service within the industry.

Applicants should preferably have an Honours degree in

engineering or physics, but lower qualifications with appropriate experience will be considered. Previous experience of the gas industry is not essential. Applicants should be self motivated and be able to communicate well, both verbally and in writing.

Initial salaries will be based on qualifications and experience, on a scale rising to £7894 or £8577 (inclusive of Inner London Weighting under review). Reference WH/156/NS.

## SCIENTISTS AND ENGINEERS

up to £8577

A limited number of vacancies for suitably qualified scientists or engineers to take part in a variety of projects in the field of combustion and heat services related to the domestic and commercial utilisation of gas. Investigations now in progress include the following interests: flame and combustion; disposal of combustion products; burner design and gas properties; ventilation studies; gas heating systems and controls; gas metering; energy conservation; installation engineering; environmental and comfort studies; appliance reliability; heat requirements of buildings.

Applicants should hold a degree, preferably in physics or a relevant branch of engineering, and have an interest in practical and applied research and development work, with a flexible outlook and technical ingenuity. A numerate training will be an advantage.

Appointments will be made at an appropriate level on a scale rising to £7894 or £8577, (inclusive of Inner London Weighting under review).

A few vacancies at HND or HNC level may also be available. Reference WH 161 NS.

## HEAT PUMP DEVELOPMENT

up to £8577

Two graduate engineers are required to take responsibility for new projects being undertaken in the field of heat pump design, development and operation.

**Heat Pump Cycles** - Chemical Engineer to undertake theoretical and practical studies of thermodynamic cycles for advanced heat pumps, and to be responsible for the development of an interactive design model for the evaluation of heat pump fluids and systems, generating the required properties by experimentation if necessary. Applicants should hold at least an Honours degree in chemical engineering, with recent experience in transfer mechanisms and computer modelling, using both main-frame and mini-computers. Reference WH/162 NS.

**Heat Pump Development** - Engineer to undertake the detailed design of heat pump components, with their con-

struction to prototype stage, and performance and life-testing. This will involve extensive use of computerised data-logging equipment. Applicants should hold a good Honours degree in mechanical engineering, or related engineering discipline, with knowledge of laboratory testing techniques and computing. Familiarity with heating systems will be an advantage. Reference WH/163 NS.

Both appointments will be made on a scale rising to £8577 (inclusive of Inner London Weighting under review) at a level appropriate to qualifications and experience.

**For above vacancies please write for an application form, quoting relevant reference number, to Administration Manager, British Gas, Watson House, Peterborough Road, London SW6 3HN, or phone Mrs. White on 01-736 1212 ext. 511 during business hours.**

## SCIENTIST

Coal Gasification

up to £7894

A Scientist is required to work on studies of coal and its gasification including the examination of coal by optical microscopy and related techniques. You would be expected to follow an interest in the outcome of these studies to the plant stage. In addition you would be required to take part in the work of a section giving a range of specialist advice and technical support to operational activities within British Gas. Suitable candidates should be graduates, and have some appropriate and related experience.

Starting salary will depend on qualifications and experience but will be within the range £5747-£7894 (including Inner London Weighting under review).

For further details and an application form, contact the Assistant Manager (Research Administration), British Gas, London Research Station, Michael Road, Fulham, London SW6 2AD, quoting reference LRS/117/NS.

**All the above vacancies are open to men and women and offer the benefits normally associated with a large progressive organisation.**

**BRITISH GAS**



## INFORMATION RESEARCH LIMITED

requires an

# INFORMATION SCIENTIST

to join their expanding company which has a proven record in the provision of information to industry and commerce throughout the world. Experience in this type of work is essential, together with an appropriate science based qualification preferably in chemistry. A lively and enquiring mind and an awareness of the role of industry in current life, are necessary prerequisites. Other basic requirements include the ability to work without supervision and to express oneself logically on paper as well as the ability to work to a deadline. The work is constantly varied and includes the gathering and assessment of information by means of literature searches, compilation of bibliographies, liaison with outside sources and the preparation of reports. Some travel may be necessary. Salary between £5000-£5500 depending on experience and background and will be reviewed regularly.

Please write to Mrs C. Fuller, Information Research Ltd, Bond Street House, 14 Clifford Street, London W1X 1RE.

## NATIONAL UNIVERSITY OF LESOTHO

### Applications are invited for the CHAIR OF MATHEMATICS

The University is seeking a versatile mathematician with an active interest in undergraduate teaching and research preferably applicable to the needs of a developing country. A particular interest in the problems of teaching mathematics at pre-University level would be welcomed. The University has a four-year degree programme with O-level entry. The Department teaches a wide range of courses including Computer Science, and is also responsible for the teaching of service courses in other Faculties. The appointment will be on permanent terms or, as is normal, for four years in the first instance, renewable by mutual consent. Post tentable from 1 August, 1980 but alternative date can be arranged by mutual consent. Salary (under review) R52936-R9000 pa (£ sterling=R1.81). The British Government may supplement salary in range £5160-6022 pa (sterling) (reviewed annually and normally free of tax) plus associated benefits: Family passages; baggage allowance; gratuity or superannuation; education allowance; overseas leave; inducement allowance or supplementation. Detailed application (two copies) with curriculum vitae and naming three referees to be sent direct to Assistant Registrar (Appointments), National University of Lesotho, Roma, Lesotho by 15 February, 1980. Applicants resident in the UK should also send one copy to Inter-University Council, 90-91 Tottenham Court Road, London W1P 0DT. Further details may be obtained from either address.

## WELSH NATIONAL SCHOOL OF MEDICINE (University of Wales) Department of Medicine

# TECHNICIAN

required in the Dermatology Section of the above Department at the Medical Teaching Centre, Heath Park, Cardiff.

The duties will be mainly histological and some laboratory experience in histological techniques is essential.

Applicants should be educated to at least ONC or A level standard. The post will be for up to one year in the first instance with the possibility of renewal thereafter. Salary within the range £1746-£3846 (£3381-£4092 from 1 April, 1980). Starting point dependent upon qualifications and experience.

Further particulars and application forms (quoting ref. M6/24) available from the Registrar and Secretary, Welsh National School of Medicine, Heath Park, Cardiff CF4 4XN. Further information from Mr A. Pearce (Cardiff 755944 Ext. 3746).

## THE UNIVERSITY OF HULL Department of Biochemistry A TECHNICIAN

is required to assist in various research projects in the Departmental Chemostat & Fermenter Suite. Minimum qualifications: ONC in Sciences (or equivalent) plus three to four years background experience in Biochemistry. Some additional experience in Microbiology, although not essential, would be advantageous. Salary on the scale E3372-3540 per annum.

Applications, giving details of age, qualifications and experience should reach the Technical Staff Officer, University of Hull, Hull HU8 7XS by 28 January, 1980 quoting the names of two referees and Ref. No. TBCH/1.

# Mental Illness Research Senior Biologist

We wish to appoint a Senior Biologist to lead an expanding research team involved in the discovery and development of new drugs for the treatment of mental illness.

Candidates should have several years' experience at post-doctoral level in the biochemical aspects of mental illness and an appreciation of the relevance of behavioural studies. The person appointed will play an important role in directing the company's effort in this field of medicine.

Although previous experience in the pharmaceutical industry is desirable, personal drive and an ability to motivate supporting staff are more important. Our research laboratories are situated in Nottingham and supported by good library facilities.

The salary offered will reflect the importance of the appointment. Company benefits include profit sharing and staff purchase privileges. Generous help with relocation to the area is available, if applicable.

Please write or telephone for an application form to: Tom Flower, Employment Manager (Technical).

## The Boots Company Limited,

Station Street, Nottingham, NG2 3AA.  
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# New Positions in R & D with Tate & Lyle

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A significant increase in our research activities coupled with the opening of new chemical production operations has led to the creation of several exciting and highly interesting new positions.

## Senior Applications Chemist

to take a central role in guiding the development of carbohydrate-based speciality chemicals, which will involve building up a laboratory for physical testing to determine the utility of new organic chemicals. Experience in applications development in the plastics, polymers or paints industry or a related field is important, but above all, you must have the ability to bridge the gap between pure chemistry and market needs. At least 5 years' experience in the chemical industry following formal academic training is required.

## Process Chemist

to lead a small team engaged in laboratory and pilot plant development of complex synthetic processes for a range of carbohydrate-derived fine chemicals. At least 5 years' experience and a demonstrable record of success in development in the chemical industry are essential.

## Food Technologist

to join a multidisciplinary team engaged in the development of a range of novel food additives, especially sweeteners, emulsifiers and thickeners. Reporting to the Project Manager, Food Chemistry, you will be responsible for exploiting the full potential of new products in a wide range of foods and beverages. A sound understanding of basic principles coupled with drive, imagination and enthusiasm are essential, as are an honours degree in Food Science/Technology and 3-5 years' experience, preferably in industry. A successful record in product development would be a distinct advantage.

## Biochemist

to join our Enzyme Technology Department to develop novel biological conversion systems. The Department has a record of successful innovation in immobilised enzymes and microbial cell research and development and is seeking to extend the use of this technology in the Company's food and chemical operations. Probably aged 24-28, you must have a wide interest in biochemical topics. An unorthodox approach to problems would be valuable as would some experience of microbiological techniques.

Competitive salaries will depend on qualifications and experience and excellent fringe benefits include a non-contributory pension scheme and free meals.

Please write, enclosing a full c.v. to The Director, R & D (FPA), Tate & Lyle Limited, Group Research & Development, P.O. Box 68, Reading, Berks RG6 2BX.



## Tate & Lyle

# Administration Officer

## Pharmaceutical Products R&D

We are E.R. Squibb and Sons Ltd., the UK subsidiary of the Squibb Corporation which is a major multi-national producer and distributor of a wide range of pharmaceutical products.

Due to internal promotion we now require a highly organised man or woman to act as Administration Officer in our International Development Laboratory.

You'll co-ordinate the production, testing, packaging, despatch and documentation of new drugs for clinical and registration trials throughout the world.

Ideally you'll have a Science Degree and some years' experience in the chemical or pharmaceutical industry. A knowledge of accounting and laboratory safety would be useful for your administrative duties, but this is not essential as training will be given.

It's a demanding job, which offers an outstanding opportunity to develop your administrative talents towards a management position and you'll be encouraged to study for your Diploma in Management Studies, for which a half-day release will be given.

In addition to an attractive salary, you'll enjoy many first rate company benefits, including a non-contributory Pension and Life Assurance scheme, a subsidised canteen, flexible working hours and 20 days paid annual holiday. Generous relocation expenses will also be paid where appropriate.

Based near the M53 our site offers easy access to the Lakes, Walsley, Manchester and Liverpool. The seaside and attractive Cheshire countryside are also within easy reach of the area and social, cultural, housing and education amenities are very good.



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If you'd like to find out more, telephone or write to Dennis Palmer, Employment and Training Manager, E.R. Squibb and Sons Ltd., Reeds Lane, Moreton, Wirral, Merseyside, L64 1QW. Tel: 051-677 0171.

## ULSTER

### THE NEW UNIVERSITY

#### SCHOOL OF BIOLOGICAL AND ENVIRONMENTAL STUDIES

#### POSTGRADUATE RESEARCH ASSISTANT

Applications are invited for a NERC supported Research Assistantship for 3 years from 1 April or 1 October, 1980 to study the hydrological effects of arterial drainage on the River Main, Co. Antrim, Northern Ireland. Candidates should have a degree in Environmental Science or Geography or a background in science. Students expecting to graduate in the summer of 1980 are encouraged to apply.

Salary scale (with FSSU/USS): £3775-£4055-£4333 p.a.

Further particulars may be obtained from The Registrar, The New University of Ulster, Coleraine, Co. Londonderry BT52 1SA (quoting Ref: 80/6) to whom applications, together with the names and addresses of three referees, should be sent not later than 28 February, 1980.

## EDITOR

A commissioning editor is required to develop Plenum's expanding programme of publishing proceedings of scientific conferences held in UK and Europe. The editor will be responsible for making initial contact with conference organisers and will liaise through to receipt of camera-ready manuscripts.

Suitable candidates would probably have a science degree. Some editorial experience would be an advantage but is not essential. Starting salary will correspond to qualifications and experience.

Please apply with full c.v. to:

THE LANGUAGE OF SCIENCE  
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Ken Derham  
Plenum Publishing Co Ltd  
2 Chandos Road  
London NW10 6NR

#### SENIOR LABORATORY ASSISTANT

required for Environmental Consulting Firm

Experience of chemical analysis is essential and a knowledge of biological techniques would be an advantage. Salary negotiable. Four weeks holiday. Must be car driver.

Apply with career details to:

H. B. Berridge at 104 Eaton Place, London SW1 by 17 January, 1980.

KING'S COLLEGE HOSPITAL  
MEDICAL SCHOOL  
(University of London)  
Dumfries Hill, London  
SE1 8RX.

#### RESEARCH TECHNICIAN

Technician or Research Assistant required with experience in pharmacological techniques, preferably involving smooth muscle. Knowledge of 'basic' computer language an advantage but not essential.

Please telephone Professor A. Bennett 01-274-0025 Ext. 3443 or write to the Department of Surgery at the above address for further details. Applications with the names and addresses of two referees should be sent to the Secretary of the Medical School as soon as possible at the above address.



## INSTITUTE OF CRYOGENICS

Applications are invited for post-doctoral and graduate assistant vacancies on the following projects in the newly-created Institute of Cryogenics.

1. Enhanced boiling heat transfer in cryogenic liquids.
2. Heat transfer and flow in liquid helium for 3000 rpm superconducting machines.

Previous experience in cryogenics preferable but not necessary.

Salaries: up to £5000 (under review) for postdoctoral positions; up to £4000 (under review) for graduate positions.

Starting point dependent on qualifications and experience.

Applications, giving a brief curriculum vitae and the names of two referees, should be sent to: Dr. A. S. Copland, The University, Southampton SO9 5NH, quoting reference 234/R/NSC.

## EAST BERKSHIRE HEALTH DISTRICT

(Wexham Park Hospital, Slough and King Edward VII Hospital, Windsor)

### SENIOR MEDICAL LABORATORY SCIENTIFIC OFFICER

#### MEDICAL LABORATORY SCIENTIFIC OFFICER

Applications are invited for the above vacancies, from suitably qualified state registered graduates.

The laboratories are well equipped and provide facilities for a District Multi-channel and Sub-regional Immuno-assay service.

The successful candidates will be based mainly at Wexham Park Hospital.

For further details contact Mr I. Eddolls, Senior Chief Medical Laboratory Scientific Officer, Slough 34507 Ext. 327.

Application forms may be obtained from the Departments of Wexham Park Hospital, Slough, Berks.

## UNIVERSITY OF MANCHESTER

### RESEARCH ASSOCIATE

An Engineer/Physicist/Materials Scientist is required for a three year research project to develop a new prosthetic device for human bladder drainage. The work, which would be suitable for a higher degree or for a post-doctoral scientist, will involve the application of the mathematical and hydrostatic bases of bladder function and the establishment of the design and construction of the prosthesis in relation to the anatomical structures in which it is placed. It is part of a multi-disciplinary project in the Department of Geriatric Medicine in association with the Departments of Medical Physics, Mechanical Engineering and Materials Science. Salary range pa: £4035-£7021. Further information from Professor J. C. Brocklehurst, University of Manchester, Department of Geriatric Medicine, Withington Hospital, Nell Lane, Manchester M20 6LR.



# B.Sc. and an eye for business?

This is an excellent career opportunity for a young engineering or science graduate or an Accountant to take a route to the top in business management.

We're looking for someone, male or female, to help formulate and develop, in conjunction with senior management, resource plans to meet the objectives of one of the world's top engineering based organisations. The successful candidate will also be responsible for monitoring actual performance against that planned, and working closely with functional managers to clearly identify, articulate and resolve any variances that may arise.

To join us you'll need to be strongly self-motivated, and with an ability to communicate effectively at all levels and across disciplines, and have had at least two years' experience in a well developed analytical environment.

If you can meet our requirements you'll find yourself part of a top professional team where ability and talent are recognised and rewarded, and where career development is both positive and planned.

We're offering a competitive salary around £7,500 and an excellent benefits package. If you have to move house, you'll find that we can offer generous assistance with relocation, including subsistence and travelling expenses for the period prior to moving. There is a very active sports and social club which includes sailing and squash. The job is located at Welwyn Garden City.

For an application form and information package, please telephone or write to Suzy Johnson, Rank Xerox Engineering Group, Monks Way, Linford Wood, Milton Keynes, Buckinghamshire, MK14 6LA. Telephone 0908 312870.

## RANK XEROX

ENGINEERING GROUP

## Microbiologist

A Microbiologist is required to join a small team working on all aspects of dairy microbiology within the Technical Division at our Thames Ditton Head Office.

The microbiology laboratory carries out an advisory and investigational service, which involves a certain amount of work in dairy establishments throughout England and Wales.

The successful applicant should have a relevant degree plus 1-2 years' experience in a food related industry. However, as full training will be given, recent graduates would be considered. A current driving licence is desirable.

We offer a good starting salary, other benefits and an unusually extensive range of sports/social facilities on site.

**MMB**

Please phone or write for an application form quoting ref. AQ.441, to: The Personnel Manager, Milk Marketing Board, Thames Ditton, Surrey KT7 0EL. Tel: 01-398 4101, ext. 340.

## PLASMA FRACTIONATION LABORATORY, OXFORD

(a Central Laboratory of the National Blood Transfusion Service)

## SENIOR TECHNICIAN in PLASMA FRACTIONATION

required in the section engaged in production of concentrates of human plasma fractions for the treatment of patients with disorders of blood coagulation. The vacancy arises because of expanding work of the section and internal promotion.

**Qualifications required:** Minimum HNC or pass degree in an appropriate subject, followed by at least five years' relevant experience, preferably in preparative biochemistry in the pharmaceutical industry.

**Salary scale:** £5403-£7140 p.a.

Applicants with appropriate academic qualifications, but whose experience is not immediately relevant to the Senior Technician Grade in this post, may be considered for appointment to the Technician Grade for a period of further training with the possibility of early promotion if successful.

Write for application form and further details to **The Secretary, Plasma Fractionation Laboratory, Churchill Hospital, Oxford OX3 7LJ.**

# Chief Analyst- Quality Control

## Pharmaceuticals Manufacture £8,000+

A vacancy exists in an expanding pharmaceutical company situated in S.E. England for a Chief Analyst in the Quality Control Department. The company manufactures a range of parenteral and oral dose products, mainly of biological origin.

The Chief Analyst will be responsible for the co-ordination of the work of the microbiological and chemical laboratories which comprises a team of 14 staff. The principal duties will be to ensure that time schedules are met for the release of raw materials, finished products and intermediates; and that the results of an extensive microbiological and particulate monitoring programme are reported and acted upon efficiently.

The person appointed, male or female, will need to have the following qualifications and experience:-

1. A Degree in Chemistry/Biochemistry, Microbiology or Pharmacy and/or Graduate membership of one of the professional institutions.
2. Aged between 25 and 35 with at least 5 years' previous experience in the pharmaceutical industry in Q.C. or Q.A. with extensive knowledge of microbiological standards required in a modern parenteral products manufacturing unit as well as an understanding of chemical and biological methods of analysis.
3. Proven managerial skills.
4. To be a Qualified Person in terms of the 1968 Medicines Act.

An attractive salary will be offered with competitive benefits including contributory pension scheme, free life assurance, BUPA and relocation assistance where appropriate.

Please write in confidence with full details and quoting ref. SA/NS/657

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MANAGEMENT SELECTION

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Experienced and responsible person required to undertake and supervise a wide range of analyses in the brewing and packaging control laboratories. The person appointed will report directly to the Chief Chemist. Applicants should have HNC or equivalent in Chemistry or Applied Biology.

### TECHNICIAN

The successful applicant will undertake a range of duties in the brewing and packaging control laboratories. This position involves shift work for which premium payments are made, in addition to the basic salary. Applicants should have ONC or equivalent in Chemistry or Applied Biology.

Salaries will be commensurate with the position offered. There are 30 days annual leave. In addition, generous fringe benefits will be offered.

Applications in writing, giving full personal details, including current salary, to:-

J. C. Cinnamond, Chief Chemist,  
Charles Wells Limited, The  
Brewery, Havelock Street, Bedford  
MK40 1GA

### UNIVERSITY OF DURHAM

Department of Chemistry

### Applications are invited for a TEMPORARY LECTURERSHIP IN PHYSICAL CHEMISTRY

tenable for two years from 1 October, 1980. Candidates should preferably have experience in solid state chemistry either from the spectroscopic or the structural viewpoint. Candidates should also be prepared to undertake teaching of undergraduates on a fairly broad front. Lecture courses may include some inorganic chemistry and mathematics as well as physical chemistry.

Salary on scale £4535-£8992 (under review) plus superannuation.

Applications (three copies) naming three references should be sent by 1 March, 1980 to the Registrar and Secretary, Science Laboratories, South Road, Durham DH1 1LE, from whom further particulars may be obtained.

### THE HATFIELD POLYTECHNIC SCHOOL OF ENGINEERING RESEARCH ASSOCIATE COMPUTER APPLICATIONS

As a result of the continued expansion of research and consultancy activities a requirement has arisen for a Research Associate to work on an interesting and challenging assignment in the field of computer applications. There are two major projects of particular interest at the present time, namely:

1. The development and documentation for commercial application of scientific programmes resulting from various on-going research projects; and
2. Investigation of appropriate hardware-software interfaces which will allow groups of microprocessor based development systems access to common facilities on a multi-user basis.

The actual assignment will depend on the experience and interests of the successful applicant and registration for M Phil may be possible.

The appointment is for two years (carrying a fixed salary of £4100 per annum) and will provide valuable training for further work in associated fields. Applications are invited from graduates holding (or expecting to obtain shortly) either a degree in computer science plus some experience of engineering programmes, or a degree in engineering or physics with a good knowledge of Fortran programming.

Application forms may be obtained from the Staffing Office, The Hatfield Polytechnic, P O Box 105, Hatfield, Beds AL8 9AE, or telephone Hatfield 88100, extension 389. Please quote ref. 309.

Closing Date: 1 February 1980

## ANALYTICAL CHEMIST

The Brewing Research Foundation, Nutfield, Surrey, requires a graduate Analytical Chemist with experience of GLC for the analysis of beer and of the raw materials used by the industry. Candidates should have about three years post graduate experience.

The initial salary will be between £4400 and £4970, but with good prospects of promotion to higher scales.

The Foundation offers pleasant conditions including 4 weeks annual holiday and a pension scheme.

Applications, including curriculum vitae and names of two referees, should be sent to: The Assistant Director, Brewing Research Foundation, Lyttel Hall, Nutfield, REDHILL, Surrey RH1 4HY.

M.R.C. Clinical Research Centre, (Northwick Park Hospital)  
Watford Road, Harrow, Middx. HA1 3UJ

## TECHNICIAN

Required in the Division of Immunological Medicine (Head: G. L. Asherson) to work on the control of the immune response. Previous experience in immunology essential. Applicants must hold HNC or science degree.

Salary within the range £4523 to £6215 pa incl. London weighting. Details and application form from Mr A. Mariner 01 944 5311 ext. 2685, quoting ref. 118/2/412. Closing date 7.2.80

### BARNET AREA HEALTH AUTHORITY

Edgware/Hendon Health  
District

### Edgware General Hospital QUALIFIED PHYSIOLOGICAL MEASUREMENT TECHNICIAN (Audio)

required part-time for duties at this busy General Hospital. Hours will be arranged up to a maximum of 21 per week. However, additional hours may be available in the future. Salary pro rata to £3896 per annum.

For further details and application form contact the Personnel Department, Edgware General Hospital, Edgware, Middx HA8 0AD. Tel: 01-252 2581, ext 252.

### SENIOR LABORATORY ASSISTANT

required for Environmental Controlling Firm. Experience of chemical analysis is essential and a knowledge of biological techniques would be an advantage. Salary negotiable. Four weeks holiday. Applicant must be a car driver.

Apply with career details to: H. B. Berridge & Partners, 121 New London Road, Chelmsford, Essex CM2 6QT by 31 January, 1980.



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Both posts offer the opportunity to gain experience in Pilot Plant and process commissioning work.

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A first degree graduate (male or female) with a good honours qualification in Chemistry is required to join the team working on new organic syntheses for the Division's established and future products. Reference 1909/79.

## Senior Technical Assistant

Working in the same field as above you will need at least 'A' level Chemistry. Facilities for further education under our Day Release Scheme are available. Reference 1891/79.

Commencing salaries, commensurate with qualifications and any previous industrial experience, are competitive and we can offer a substantial range of benefits which will include relocation expenses where appropriate.

Please write or telephone for an application form (quoting reference number) to the Personnel Manager, Fisons Agrochemical Division, Freeport, Hauxton, Cambridge CB2 1BR (no stamp if posted in the UK).

Tel: Cambridge 870312 or 870024  
(Ansfone Service).



### KING'S COLLEGE HOSPITAL BASIC OR SENIOR PHYSIOLOGICAL MEASUREMENT TECHNICIAN

Applications are invited from people who are working in the field of Cardiology and wish to work in one of London's busiest teaching hospitals. Candidates should have relevant experience and qualifications. Grade of post yet to be decided. Salary scale: Basic £3896-£4874. Senior £4718-£5810.

Informal visit can be arranged to departments, please contact M. Monaghan, Chief Technician, on ext 2647. Application form and job description available from Sector Administration, King's College Hospital, Denmark Hill, London SE5 9RS. Tel: 01-274 6222 ext 2408. Please quote ref no SA/117. Closing date: 31 January, 1980.

### ST THOMAS'S HOSPITAL MEDICAL SCHOOL (University of London) London SE1 7EH

Department of Virology  
JUNIOR MEDICAL  
LABORATORY SCIENTIFIC  
OFFICER

required for busy diagnostic and research virus laboratory. Ample opportunity to study for MSc and PhD examinations. Applications with details of educational qualifications should be sent to Mr J. Bertrand, Chief M.S.O. Department of Virology, St Thomas's Hospital Medical School. For further information please telephone 01-226 3262 ext 2156/2256.

### UNIVERSITY COLLEGE LONDON

Department of Mechanical  
Engineering  
RESEARCH ASSISTANT

required to work jointly with the Biomechanical Research and Development Unit of DHSS on development of Artificial Limbs made from polymers. Work is concerned with choosing suitable materials and processing variables to achieve desired properties in final product. Contact with disabled patients is likely.

Location Hinchley Wood, Surrey, with existing research group for experimental work, in close liaison with the College.

Candidates (normally under 30) should have honours degree or equivalent in polymer science, mechanical engineering or related subject. Experience in relevant field an advantage. Salary £4335-£4910 London Allowance. Appointment for up to 3 years.

Applications with c.v. and names of two referees to Dr W. J. D. Jones, Department of Mechanical Engineering, UCL, Torrington Place, WC1E 6BT.

### THE NATIONAL TRUST BOTANIST

required to join a small team engaged in a biological survey of National Trust properties. An Honours degree, a working knowledge of the British flora and a strong interest in field ecology are essential. Write for details, enclosing s.a.e., to The National Trust, Botanical House, 100, Weymouth, Cirencester, Glos GL7 1QG. N.B. Applications from candidates due to graduate in 1980 will not be considered.

### UNIVERSITY OF MANCHESTER ELECTRONICS DESIGN ENGINEER

Applications invited for this post (in the experimental officer grade) in the Physics Department. Duties are: to assist academic staff in design and development of analogue and digital systems, including the use of small commercial computers; and to be responsible for the organisation and running of the electronics workshop, including the planning of workshop facilities, advice on provision of equipment for research and teaching, and supervision of a group of electronics technicians. Salary range per annum (according to qualifications and experience): £3775-£5355 (£4335-£5751; or £7227-£8892). Superannuation. Particulars and application forms (returnable by 25 January) from the Registrar, The University, Manchester M13 9PL. Quote ref: 256/79/N5C.

### UNIVERSITY OF LEICESTER ANIMAL HOUSE LABORATORY TECHNICIAN (GRADE 5/4)

Applicants for this vacancy should be studying for I.A.T. qualification and have appropriate experience. Salary, depending upon qualifications and experience, within the range £5337-£6286 p.a.

Further details can be obtained from Mrs L. Bradshaw, The Secretary, Animal Unit, Medical Sciences Building, University of Leicester. Tel: Leicester 351254 Ext 224.

### RESEARCH LIAISON OFFICER

The Research and Statistics office of the Royal Institute of British Architects requires somebody to take responsibility for administering and developing the Institute's role in architectural research. The job holder would act as secretary to the Institute's Research Steering Group, administer the research awards scheme and maintain liaison with people and organisations engaged in funding and carrying out relevant research. The post would be suitable for a graduate with relevant experience in research or research administration or a background in Architecture/Building Studies. The salary will be on a scale from £5303.73-£7523.25 depending on experience.

Application forms can be obtained from the RIBA, 46 Portland Place, London W1N 4AD.  
Tel: 01-580 5533 Ext. 254.

### THE UNIVERSITY OF MANCHESTER

TEMPORARY LECTURESHIP  
IN ATOMIC AND  
MOLECULAR PHYSICS

Applications are invited for the above post from persons with research experience with qualifications in physics or chemical physics. The successful candidate will be expected to carry out experimental work in the field of atomic and molecular spectroscopy, and to participate in the teaching programme of the Physics Department. Some preference will be given to individuals with experience in laser spectroscopy. The appointment will be made as soon as possible with an initial salary in the range £4335-£5189 per annum (subject to review) and will be for a period of three years in the first instance. Application forms and further particulars may be obtained from the Registrar, The University, Manchester M13 9PL, to whom completed forms should be returned by 16 February, 1980. Quote ref. 257/79/N5C.

### TWO GRADE 1B OR 2B TECHNICIANS

required to join a team servicing undergraduate pharmacology teaching laboratories. A minimum of 'O' level Biology is essential and preferably 'A' level or a relevant technical qualification. There will be an opportunity to assist in research work or in the specialist service areas. These appointments are for a fixed term of three years. Salary: Grade 1B £2943-£5135pa (under review); Grade 2B £3174-£5612pa (under review) plus £780pa London Weighting. Five weeks holiday plus Easter and Xmas breaks. Applications stating all relevant particulars to: Personnel Officer, The School of Pharmacy, 28-30 Brunswick Square, London WC1N 1AX.

### TECHNICIAN (Grade 3)

required in Department of Microbiology, University of Reading to prepare, supply media for classes and to assist a small group in research on some aspects of Microbiology. Salary scale £1322-£3553 per annum (under review). Apply with names of two referees (including Prof T.S. Oja, Assistant Bursar (Personnel), University of Reading, Whiteknights, Reading RG6 2AH.

## Project Leaders/ Technologists

### Metal Finishes – Wantage

Metal Box is the largest packaging company in Europe and has recently moved its Research and Development Division from London to a new purpose-built Technical Centre at Wantage.

As result of this move we now have vacancies for men and women to carry out and control a wide variety of project work relating to the development of protective and decorative finishes for metal containers. This will involve working with a small team but with the full support of the R & D Division's resources. The work will also entail providing a technical support for production factories in the UK and overseas.

A science or technology degree is essential, preferably coupled with relevant practical experience in the paint, coatings or printing industry. An important requirement is the ability to analyse problems from both practical and theoretical standpoints.

A competitive salary is offered, with a wide range of company benefits and excellent career opportunities.



## Metal Box

Research & Development Division

Please telephone or write for an application form to G. P. Smith, Recruitment Manager, Metal Box Limited, Denchworth Road, Wantage OX12 9BD. Telephone: Wantage 2929.

## Leader— Technical and Economic Surveys Industry Energy Studies

Up to £8775 p.a.

A scientist/engineer is required to lead a group of graduates engaged in technical and economic studies of existing and potential R and D projects, mainly related to industrial energy usage. The team is also concerned with the appraisal of existing R and D projects undertaken at the Midlands Research Station. The work involves studies of market size, identification of areas of possible research work and estimating the economic viability of new developments. A considerable amount of work will be carried out in liaison with other parts of British Gas, manufacturers and customers.

The ideal candidate will have a good honours degree in science or engineering, some years experience of technical and economic assessment of industrial processes and preferably some research and development experience. A knowledge of industrial energy usage and the energy industries would be useful. The ability to lead a group of graduates and to write clear and concise reports is essential.

The salary for the job will be in the range £6795–£8775 p.a.

Write for an application form, quoting reference number MRS/287 to

Research Secretary,  
British Gas Corporation,  
Research and  
Development Division,  
Midlands Research Station,  
Wharf Lane, Solihull,  
West Midlands B91 2JW.

**BRITISH  
GAS**

### THE UNIVERSITY OF LEEDS PROCTER RESEARCH FELLOWSHIP

#### Chemical Physics of Gelation

Applications are invited for a post of

### POSTDOCTORAL RESEARCH FELLOW

to study gelation of water-soluble macromolecules by physical techniques, including laser light-scattering and photon correlation spectroscopy. The appointment will be held in the Procter Department of Food Science.

Applicants should have (or expect to have on appointment) a PhD in physical chemistry, chemical physics or polymer physics. Previous light-scattering experience would be an advantage but is not essential. The successful applicant will work in association with Dr E. Dickinson and Dr G. Stainsby of the Procter Department of Food Science. The appointment will be made for a fixed term of either one or two years.

Salary on the IA Scale for Research and Analogous Staff £4333–£7521 (under review) according to age, qualifications and experience.

Application forms and further particulars may be obtained from the Registrar, University of Leeds, Leeds LS2 9T, quoting reference number 727/E. Closing date for applications 31 March 1980.

## Scientific Officer

£3655–£5236

To be based at our Sewage Treatment Works in Isleworth, Middlesex.

The successful applicant will work in an investigations team engaged on investigations and research primarily connected with sewage treatment and sludge disposal through the Division. He/she will be expected to work on any site within the Division and also at an Authority farm near Oxford as required. The major portion of the work will consist of analytical work on a large research contract, and will involve extensive use of Atomic Absorption Spectrophotometry.

If you have 4 'O' levels, including Chemistry, and would like to work in a happy environment with excellent conditions of service, including 4 weeks holidays and a pension scheme, please write for an application form to Phil Perkins, Personnel Branch, 4th Floor, Broadway Buildings, 50-54 Broadway, London, SW1H 0DB, (telephone 01-222 6200), quoting reference 182.

## Thames Water

## MICROPROCESSOR PROGRAMMERS

Microprocessor Programmers are urgently needed for projects in the real-time control field. They will join an active team working on advanced new product development.

The positions would suit recent graduates with experience of microprocessor work.

We offer, in addition to interesting and satisfying work, the career opportunities inherent in a large and progressive Group and the enjoyment of a small company environment.

Please apply, with brief details of age, qualifications and experience to:— The Engineering Manager SGRD Limited, Concord Road, London W3 8SE.



# Plant Scientist-Herbicides

As a result of continued expansion we have a vacancy for a young graduate Plant Scientist, preferably with a Ph.D. and with a good background in crop protection.

The two main aspects of the job are:

- To develop and implement a programme for the biological evaluation of candidate herbicides in greenhouse and field.
- To work in a team evaluating and developing new herbicides for use in Europe.

Experience in plant physiology/herbicide behaviour would be an advantage.

An attractive salary is offered together with a non-contributory pension and life assurance scheme, subsidised BUPA, four weeks holiday, and help with re-location expenses where applicable.

Please write for an application form to:

**Martin Neville, Personnel Manager.**



**LILLY RESEARCH CENTRE LIMITED**  
ERL WOOD MANOR, WINDLESHAM, SURREY.

**ELANCO**



**LOUGHBOROUGH  
UNIVERSITY OF  
TECHNOLOGY**

## LECTURER IN COMPUTING

Applications are invited for the post of Lecturer in the Department of Computer Studies. An interest in business and management information systems, micro-processor applications or mathematical software is required and some research, industrial or commercial experience would be preferred.

Salary within scale £4333-£8992 (under review). It is hoped to appoint within the lower half of the scale. Postcard requests for further information and application form to Paul Johnson, Establishment Officer, ref. 80/1 CO.

## MULTICOMPUTER SYSTEMS RESEARCH

Applications are also invited for two posts as Research Assistants to work on an SRC sponsored project to create a four processor computer system using production minicomputers with some shared memory. Both posts will be concerned with designing and writing systems software to permit simultaneous multiprocessing and multiprogramming on the system.

One appointment is for a maximum of 3 years, the second for one year, at starting salaries up to £5199 (under review). Write giving details to Professor D. J. Evans, Department of Computer Studies, from whom further information may be obtained.

Loughborough Leicestershire

## Your Interest in Chemistry Could be the start of a Professional Career!

We are the Thames Water Authority, responsible for water supply and management over a wide area of South East England. A vital aspect of our work is in the control of pollution, carried out by experienced teams of Analysts and Scientists who keep a constant watch on our rivers and waterways. We have an opportunity for an able and ambitious young man or woman to join us as a

### Trainee Analyst

Based at the Metropolitan Pollution Control laboratories in Isleworth, Middlesex you'll join a team handling a range of work, from analysing river waters and ground waters to checking trade and sewage effluents, using both traditional and instrumental techniques. You'll be given the training you will need, and we also provide generous facilities for further study.

GCE passes in five subjects including A level Chemistry and one other science, or ONC, would be an advantage, though not absolutely essential. Your starting salary depends on age, qualifications and experience but at 18 you could be earning £3352 rising to over £6000 p.a.

So if you have the interest and aptitude why not use them to begin a professional career with Thames Water? Write for an application form to the Assistant Director Personnel—Staff, 173 Rosebery Avenue, London EC1R 4TP.

## Thames Water

**COVENTRY LANCHESTER  
POLYTECHNIC**  
Department of Materials and  
Energy Science

### SENIOR TECHNICIAN (Physical Sciences) £4000-£5047

Applicants should possess sufficient knowledge of solid state science and vacuum techniques to assist in the design and building of equipment for teaching, projects and research programmes and the operation and maintenance of such equipment.

### SENIOR TECHNICIAN £4000-£5047

Duties would include the operation and maintenance of equipment required for a programme of diffusion techniques using radioactive sources connected with teaching, projects and research work. Applicants should be able to maintain and operate X-ray diffraction and non-destructive test equipment.

Applicants for above posts must be qualified to City Guild Advanced/HNC (in an appropriate discipline) or to have at least 5 years relevant experience.

Department of Biological Sciences

### SENIOR TECHNICIAN £3720-£5547

To be responsible to the Technical Administrative Officer for organising and co-ordinating the technical services of the above department, and to assist in the development and use of analytical equipment in teaching and research. Applicants should be qualified at degree or HNC level or have fully equivalent experience.

### TECHNICIAN (PLANT SCIENCE) £3585-£4533

To service laboratories, greenhouse, practical classes and field courses, and assist in research. Applicants should be qualified at ONC, HNC or degree level or equivalent and have relevant experience, preferably including greenhouse work.

For application forms and job specifications write to the Personnel Officer, Coventry (Lanchester) Polytechnic, Priory Road, Coventry CV1 5PB (enclosing a self addressed envelope) returnable within ten days of the appearance of the advertisement.

### UNIVERSITY OF SOUTHAMPTON

Institute of Sound and  
Vibration Research  
**AIRCRAFT NOISE/SHIP  
NOISE**

Three research posts are available in a team working on noise mechanisms in fluid flows as a result of contracts awarded by the NGE and Admiralty respectively.

Applicants for post (a), to work on the transmission of core noise through nozzle flows, should have a PhD or equivalent research experience with a fluid mechanics content.

Applicants for post (b), to work on the noise of high speed jet flows, should have a good honours degree in Science or Engineering.

Applicants for post (c), an experimental study noise generation of underwater propellers, should have similar qualifications to applicants for post (b). It is intended that the latter two posts should lead to a PhD degree.

Starting salaries will depend on age and experience and the posts will be available for three years in the first instance.

Salaries on range £3775-£5488 per annum (under review).

Applications and requests for further particulars should be sent to D. A. S. Copland, The University, Southampton SO9 5NH, quoting reference 238/R/NSC.



## University of London Computer Centre

The University of London Computer Centre is a regional centre which provides computer services to schools and colleges of the University of London, South Eastern and South Western universities on its Control Data Cyber 72, 6400, 6600 and 7600 computers.

Applications are invited for the following vacancies in the User Support Group—

### Applications Programmer (Ref. 1)

An applications programmer is required to join staff engaged in the implementation, maintenance and support of applications packages. Duties will include writing and maintenance of programs to account for and control usage of computing resources.

Applicants should have a good knowledge of at least one programming language, preferably FORTRAN, and should be educated to degree or post-graduate standard. Ability to communicate clearly both verbally and in writing is essential. Candidates with data processing experience may also be considered.

### User Education Officer (Ref. 2)

A user education officer is required to prepare courses for our users on the facilities provided at the centre. The courses will vary in length and complexity although the main requirement is at an introductory level. The courses are usually designed as self-instructional units with some presented as lectures.

The applicant must be a graduate with computing experience. Teaching qualifications and experience would be an advantage.

### Documentation Officer (Ref. 3)

A documentation officer is required in the User Support Group to maintain and develop the Centre's user documentation consisting of about 150 documents, user guides and a monthly newsletter. The documentation officer edits or writes all user documents and supervises their production and distribution.

Applicants should be graduates with experience in computing and should have an ability and interest in writing.

Starting salary will be in the range £4515 to £6806 (including London Allowance) on the Other Related scale. In exceptional cases a higher starting salary may be offered.

The Centre offers excellent conditions of service including six weeks holiday and operates the Universities Superannuation Scheme.

For further details of Ref. 1 contact Dr O. C. Penge, Applications Section Head or for Ref. 2 and Ref. 3 contact Mrs J. Pateman, Advisory Section Head or the User Support Secretariat, ULCC, 20 Guilford Street, London WC1N 1DZ, Tel. 01-405-8400. Closing date is 31 January, 1980.

## Drug Metabolism & Pharmacokinetics

Huntingdon Research Centre is Europe's leading contract research organisation in drug safety evaluation. As a result of our continuing development, there are vacancies in our Department of Metabolism and Pharmacokinetics in the following areas.

### Radiosynthesis

The work will involve the synthesis, purification and quality control of radiolabelled compounds. There will also be opportunities to become involved in other activities such as the separation, isolation and identification of metabolites. Experience in radiosynthesis is desirable although not essential but proven practical ability in organic synthesis is of prime importance. You should have a PhD in chemistry or have reached an equivalent standard.

### Drug analysis

The work involves studies of the pharmacokinetics and bioavailability of drugs using a variety of analytical techniques, such as GLC, HPLC and radiochemistry. You should have a relevant qualification e.g. HNC, AIMLS, LRIC, GRIC, BSc. Experience, although desirable, is not essential, but practical ability is important.

We offer competitive salaries, progressive benefits and excellent working conditions. The Centre is located near Huntingdon in an attractive part of the country, with good access to London by both road and rail.

Please write or telephone for an application form to: Recruitment Officer,

Huntingdon Research Centre,  
Huntingdon, Cambs. PE18 6ES.  
Telephone Huntingdon  
(0480) 890431.



**Huntingdon Research Centre**

## POST DOCTORAL RESEARCH ASSOCIATE

Applications are invited for a post doctoral research associate to work on radiation effects and the physical and chemical properties of metal ion complexes with dibutyl and monobutyl phosphates. Experience in inorganic chemistry and an interest in methods of structure determination would be an advantage.

The research is supported by British Nuclear Fuels Ltd., and the post is available for one year. Commencing salary will be in the range £3312-£4910 p.a. on a London Allowance. Applications with c.v. and the names of two referees should be sent to Dr P. G. Clay, Department of Chemical Engineering and Chemical Technology, Imperial College, London SW7 2BT.

## THE NATIONAL HOSPITALS FOR NERVOUS DISEASES QUEEN SQUARE, LONDON WC1N 3BG

require a

### JUNIOR MEDICAL LABORATORY SCIENTIFIC OFFICER

to undertake duties in routine chemical pathology. Applicants should possess 5 O'levels including one science subject, English Language and Mathematics.

Facilities are available for further study.

Salary, which is dependent upon age and qualifications, is on the scale £2666-£4016 (inclusive of London Weighting Allowance).

Applications should be made in writing, giving details of experience and qualifications, and quoting the names and addresses of two referees to the Personnel Department at the above address, tel. no. 837 3611 ex. 65.

## THE UNIVERSITY OF SHEFFIELD TEMPORARY LECTURER IN INORGANIC CHEMISTRY

Applications are invited from men and women for the above SRC-financed post tenable annually for up to two further years. The person appointed will be expected to undertake normal teaching duties and to engage in research in inorganic chemistry. Tenable as soon as possible. Starting salary in range £4333-£5199 a year. Interested persons should contact Professor Maclsa, Department of Chemistry, The University, Sheffield S3 7HF (0742-78555) for further particulars. Applications (2 copies), to the Registrar and Secretary, The University, Sheffield S10 2TN as soon as possible. Quote ref: A395/H.

**LOTHIAN REGIONAL  
COUNCIL  
DEPARTMENT OF EDUCATION  
NAPIER COLLEGE OF  
COMMERCE AND  
TECHNOLOGY**

**RESEARCH  
ASSISTANT**

(Microbiology)

In the Department of Biological Sciences. (Grant tenable for at least 2 years).

An Honours Graduate in Microbiology is required to join a team of scientists studying the effects of Edinburgh City Sewage Scheme on the ecology of the Firth of Forth. The assistant will be responsible for continuing routine bacteriological and virological monitoring of sea water and mussels.

Relevant experience would be an advantage. Possession of a current driving licence is essential.

Salary on scale £247-£399

Application forms may be obtained from the Academic Registrar at the College, Colinton Road, Edinburgh EH10 5DT.

**KING'S COLLEGE HOSPITAL  
MEDICAL PHYSICS  
TECHNICIAN III**

Interesting and varied work in the Regional Neonatal Intensive Therapy Unit at this London Teaching Hospital, to look after monitoring and life support equipment used for the care of seriously ill newborn babies and also to develop new types of equipment. Applicants should have a minimum qualification of ONC, preferably HNC (or equivalent).

Salary: £5005-£6550 depending on experience and qualifications. Further details and application forms plus job description available from Sector Administration, King's College Hospital, Denmark Hill, London SE5 8RS. Tel: 01-274 6222 ext 2408.

Please quote ref no SA/120. Closing date 1 February, 1980.

**Kent County Council  
Education Committee**

**HADLOW COLLEGE OF AGRICULTURE  
AND HORTICULTURE**

**SOILS TECHNICIAN**

Applications are invited for the post of Technician to work on a wide variety of teaching and commercial projects in Agriculture and Horticulture. Salary—Technician Grade III £4000 to £4835. Practical experience in soil and plant analysis would be an advantage.

Further details and application form can be obtained from the Principal, Hadlow College of Agriculture and Horticulture, Hadlow, Tonbridge, Kent—Telephone: 0430 6100. Applications should be submitted by 1st February 1980.

**THE MIDDLESEX HOSPITAL  
MEDICAL SCHOOL  
(University of London)  
LECTURER IN PHYSICS**

Applications are invited for the post of Lecturer in Physics in the Sub-Department of Radiation Physics. Duties will include: radiological dosimetry, computerised treatment planning, quality control of high energy X and gamma ray equipment and some teaching. Salary will be in the range £5075-£9132 (inclusive of London Allowance). For further information contact: Mr T. H. E. Bryant, Department of Physics, The Middlesex Hospital Medical School, Cleveland Street, London W1P 6DB, to whom applications should be sent by 15 February, 1980.

# Virologist

V/R17

G. D. Searle is a leading pharmaceutical company with its U.K. headquarters situated in pleasant surroundings at High Wycombe in Buckinghamshire.

We currently have a vacancy for a Virologist in the Biology Department, to assist in our drug evaluation programme and in our basic research in virology.

This post would suit either a recently qualified PhD or a graduate with several years' experience. Applicants should ideally have experience in the use of animals as models for human infections, and some experience with respiratory viruses.

We offer an attractive salary, and conditions of employment include 4 weeks' holiday per year, contributory pension and private medical schemes, subsidised cafeteria, and sports and social club.

Please apply in the first instance to Miss D. Wardman, Assistant Personnel Officer, Searle Research & Development, Lane End Road, High Wycombe, Bucks (Tel. High Wycombe, 2124, ext. 3374). Please quote above reference.

**SEARLE**

**CHARACTERISATION OF  
ELECTRONIC MATERIALS  
BY X-RAY DIFFRACTION**

A vacancy exists in the Crystallography Group of the GEC Hirst Research Centre for a

## GRADUATE

to assist in the development and application of X-ray diffraction techniques for the characterisation of electronic materials. Short and long term investigations of a wide variety of poly and single crystals are undertaken.

Graduate applicants, of either sex, should have a basic, but not necessarily detached, understanding of X-ray diffraction procedures: full training will be given. Post-graduate applicants would be expected to have relevant experience. An interest in electronics would be an advantage.

Please apply, giving brief details, to: G. D. Pritchard, Administration Manager, Ref. P/053, GEC Hirst Research Centre, East Lane, Wembley, Middx. HA9 7PP.

**THE UNIVERSITY OF LEEDS  
DEPARTMENT OF BIOCHEMISTRY**

Applications are invited for a post of

## RESEARCH FELLOW

In the above Department. The work, which is financed under an MRC programme grant to Professor Donald S. Robinson, will be concerned with the molecular mechanisms of hormonal control of the activity of the enzyme, lipoprotein lipase. Applicants could usefully have an interest in the control of protein biosynthesis and degradation and/or in enzyme activation and inactivation mechanisms. A PhD. degree is required. The appointment will be made for a fixed period of up to four years from 1 April 1980 or from a date to be arranged. Salary at an appropriate point on the IA scale for Research and Analogous Staff (£4335-£7531) (under review from 1 October 1979).

Preliminary enquiries about the post will be welcomed by Professor Donald S. Robinson (Tel. (0532) 36171 ext. 81).

Application forms and further particulars may be obtained from the Registrar, The University, Leeds LS2 9JT, quoting reference number 83/26/L. Closing date for applications 1 March 1980.

**UNIVERSITY OF  
EDINBURGH**

## PHYSICIST/ PROGRAMMER

(Research Associate/Fellow)

Department of Medicine,  
Royal Infirmary,  
Edinburgh

A Physicist/Programmer is required to join a multi-disciplinary group working on the application of microprocessors and mini computers to radionuclide imaging of the heart. The appointment, for 3 years, may be suitable for registration for a higher degree.

Salary scale £4200-£5190-£5488. Further particulars from Dr. H. M. Brash, Royal Infirmary Edinburgh, (031-229 2477, ext. 2283 or 031-334 7152 evenings).

Applications to the Secretary to the University, Old College, South Bridge, Edinburgh, EH8 9YL, not later than 1st February, 1980. Please quote Reference 5001.

**QUEEN ELIZABETH  
COLLEGE  
Kensington**

(University of London)

## LECTURESHP IN MICROPROCESSOR EDUCATION

Applications are invited for a new appointment intended to contribute towards the understanding and applications of microelectronics and microprocessors as needed by both undergraduate and post-graduate science students. The appointment will be made as soon as possible.

The Lecturer should have appropriate experience in hardware and software aspects of digital technology; some knowledge of control systems would be an advantage. The post will be based within the Physics Department where facilities for research will be provided.

Salary will be on the Lecturer scale £4335-£8092 per annum (under review) plus £740 London allowance.

Further details and an application form may be obtained from the College Secretary, Queen Elizabeth College, Campden Hill Road, London W8 7AH. Tel: 01-937 5411. The closing date for applications is 23 February, 1980.

## ELECTRON MICROSCOPE TECHNICIAN

(Grade 5)

required in Plant Science Laboratories, University of Reading, to be responsible for maintenance and operation of well-equipped laboratory and to provide advice, assistance and training to microscope users. Facilities include: 100B TEM, JSM 35R SEM, freeze etching and cryo-electron microscope. Experience in wide range of preparative techniques and equipment maintenance essential. Salary in scale £5740-£4320 per annum (under review). Apply with names of two referees quoting Ref. T.S. 85A to Assistant Bureau of Personnel, University of Reading, Whiteknights, Reading RG6 2AH.

## RESEARCH ASSISTANT

required for one year to work on development and behaviour in guinea pigs and sheep in the perinatal period. Applicants should have a degree and preferably two years postgraduate experience. Some training in electrophysiology an advantage. Salary in the range of £4125-£4659. Apply, with cv to Miss M. A. Vince, MRC External Staff, ARC Institute of Animal Physiology, Babraham, Cambs CB3 4AT. Tel: Cambridge 83-693.





### ICI CORPORATE LABORATORY

The ICI Corporate Laboratory, situated in Runcorn Cheshire has a vacancy in the Design Systems Group for a

## MATHEMATICIAN

Candidates should have a good degree in Mathematics or a related subject, and a strong interest in computing.

The work of the group involves research into Chemical Process Design techniques and covers such areas as the synthesis of processes, steady state and dynamic simulation of chemical process plants and a process engineering database.

Although prior knowledge of these areas is not essential, candidates should have experience in at least one of the following: mathematical modelling, numerical analysis, software development and support, data management.

The starting salary will be up to £6500 and there is a profit sharing scheme in operation.

If you are interested in this vacancy, please write enclosing full curriculum vitae to:—

**Miss S. E. Bird, Personnel Officer,  
Imperial Chemical Industries Limited  
Corporate Laboratory PO Box 11  
PO Box 11  
The Heath, Runcorn, Ches. WA7 4QE.**



## STATISTICIAN

IRI is an expanding contract research laboratory undertaking investigations on a wide range of pharmaceutical and other products for UK and overseas clients. A statistician is now required to assist scientific staff; initially this will be by the provision of statistical support services but the duties will expand into coordinating the development of data processing systems, particularly for toxicology studies. Improvement and quality control of data handling systems in the laboratories will be a key function.

This post would be suited to a graduate or equivalent, probably over 25 years of age, with initiative and the ability to work with people in a variety of disciplines. Experience of the use of statistics in biological studies would be a valuable asset.

IRI is located near Edinburgh within easy reach of the city and surrounding areas. Relocation assistance will be available if required; there is an excellent pension plan and free BUPA. Salary will be on the scale £4968 rising to £7056 pa.

Application forms, quoting ref. 1021, are available from the Personnel Department, Inveresk Research International, Inveresk Gate, Musselburgh, East Lothian, EH21 7UB.

### UNIVERSITY OF NOTTINGHAM MEDICAL SCHOOL

Department of Human Morphology  
RESEARCH STUDENT

Applications are invited for the post of Research Student to work with Dr M. Balis and Dr R. H. Clothier on the biology of *Xenopus laevis* in relation to carcinogenesis.

Candidates should have a good degree in Biochemistry or in another biological subject. The successful candidate will be required to begin as soon as possible and to register for a PhD. The grant will consist of a maintenance allowance plus registration fees, and will terminate on 31 December, 1982.

Further particulars can be obtained from Dr Balis (0602 700111, ext 3067), Department of Human Morphology, Medical School, Queen's Medical Centre, Nottingham NG7 2UH, to whom applications (including the names and addresses of two referees) should be returned by 31 January, 1980.

### UNIVERSITY OF CAMBRIDGE

Department of Anatomy  
RESEARCH TECHNICIAN

required to join a group of about 15 studying various aspects of neuroendocrinology and behaviour. The work involves radioimmunoassay of steroid and protein hormones. Salary according to experience £2705-£3056. Applications in writing including the names of two referees to: The Principal Assistant, Department of Anatomy, Downing Street, Cambridge CB2 3DQ.

### RIVERS DIVISION

## ASSISTANT ENGINEER/HYDROLOGIST

Salary: £4,266 – £6,426 p.a.

Based in Warrington, this position will provide you with good experience in the investigation and promotion procedures for catchment modelling for flood warning purposes, hydrological investigations of resources and statistical hydrology studies on rainfall, stream flow and tidal data.

You should have a basic degree in Civil Engineering or other appropriate discipline, incorporating Hydrology, preferably enhanced by a higher degree in Hydrology or Water Resources.

Application forms from: The Personnel Officer, North West Water, Rivers Division, New Town House, Buttermarket Street, Warrington WA1 2QG. (Tel: Warrington 539999).

Closing date for applications: 1st February 1980.

The above post is open to men and women.



### CHELSEA COLLEGE University of London

Basic Medical Sciences Group  
GRADE 2B OR 3 RESEARCH/ TRAINING TECHNICIAN

is required for the Pharmacology Department. Applicants should have a minimum of three years' experience including training and ONC (or equivalent qualification).

The salary according to age and experience will be within the scales: Grade 2B £3054-£4392pa; Grade 3 £4152-£4620pa inclusive of London Allowance. There is a 37½ hour working week, 5 weeks' annual leave plus public holidays and additional days when the College is closed.

Application forms from Mr. L. Tucker, Department of Pharmacology, Chelsea College, University of London, Manresa Road, London SW3 6LX.

### SCOTTISH WILDLIFE TRUST DEVELOPMENT OFFICER

The purpose of an appointment at the Edinburgh office will be to promote the Trust and its work for nature conservation throughout Scotland. We are looking for an enthusiast about nature conservation, preferably with knowledge of wildlife, who wants to work with volunteers and has skills in public relations or marketing. A member of the small H.Q. staff team, the D.O. will also need to travel throughout Scotland and deal with a wide variety of people. Appointment is for three years at a salary about £4000 per annum initially plus pension after confirmation. Selection by interview. If you are interested in this unique job, apply before February 5 to Secretary, S.W.T., 5 Dumburg, Edinburgh 1, giving relevant knowledge and experience. Further particulars on request.

The Water Research Centre has two main Laboratories, one at Stevenage, Herts and the other at Medmenham, Bucks, and is developing an Engineering Laboratory at Swindon. With a total staff of over 500 it is the national centre for water research in the United Kingdom and is one of the largest water research organisations in the world. It is financed principally by UK Water Undertakings.



# Water Engineer or Scientist

## Scottish Office

An experienced Water Engineer or Scientist is required as Head of the Water Research Centre's Scottish Office which has recently been opened in Stirling.

The role of the Scottish Office is to ensure that the major problems facing the Scottish water industry are identified and appropriate and timely research is carried out, and that new technology and equipment developed at the Centre's Research Laboratories and computer and information and enquiry services are readily available to support the Water Undertakings in Scotland.

Chartered Engineers or Scientists who can demonstrate that they have been involved at a senior level with the design and/or operation of major water supply and wastewater treatment schemes and have the ability to put research findings to practical applications are invited to apply. Some knowledge of environmental pollution issues and recent legislation relevant to the UK and EEC is desirable.

The salary is for negotiation but could be well over £10,000 p.a. A car will be provided.

Please apply in writing, giving full details of qualifications and experience to:—

**Director of Administration**  
Water Research Centre  
45 Station Road  
Henley-on-Thames  
Oxon RG9 1BW

Closing date for receipt of applications 6 February 1980.

## COMPUTER SCIENCE FACULTY OPENINGS AT WASHINGTON STATE UNIVERSITY

Applications invited for two or more posts beginning September 1980. Appointment rank and time to tenure depend upon qualifications. Our primary interest is research, preferably in software engineering, programming methodology, databases, hardware/software specialities, and other applied fields. PhD or equivalent required. Visiting appointments also available.

The Department offers BS, MS, PhD with 16 faculty, 140 majors, 55 graduate students. We have a PDP 11/60 (Unix), microcomputers, graphics computers and graphics terminals. We maintain close relations with the computing centre, which operates a large AMDahl 470V6. WSU uses 200 terminals for interaction (Wybur/Oryl).

Please send curriculum vitae and at least three references names to: Professor David B. Benson, Search Committee Chair, Computer Science Department, Washington State University, Pullman, WA 99164, USA. WSU is an eo/aa employer.

The Chairman of an organisation which monitors the trade in endangered species of flora and fauna requires a P.A. He/she must have good secretarial skills, be able to work on their own, and able to handle own correspondence. Salary c. £4000. Apply in writing with c.v. to John Barton, TRAFFIC INTERNATIONAL, 1 Marshall Street, London W1V 1LQ.

## Senior Desk Editor - Desk Editor

Granada Technical Books, due to expansion, have vacancies for the above positions. They will share the editing and progress chasing of some fifty new books, new editions and reprints a year.

If you have appropriate editing experience in book or journal publishing we would like to hear from you.

Salary negotiable according to age, experience and qualifications. Benefits include 4 weeks annual holiday, a subsidised staff restaurant, generous Granada Group pension scheme and Life Assurance Benefits and free transport to and from St Albans.

Write or phone: David Fulton, Granada Technical Books Limited, PO Box 9, Frogmore, St Albans, Herts. Telephone 0727 72727.

## GRANADA PUBLISHING

### MECHANICAL ENGINEERING POSITION

A tenure track position in Thermal Sciences at Assistant or Associate Professor level is open in mechanical engineering at Michigan State University. Primary consideration will be given to applicants in Experimental Computation who have established research records. Duties include undergraduate and graduate teaching in Thermodynamics and combustion; supervision or graduate research and solicitation of sponsored research. Send full resume, with names and addresses of at least three references to: Dr John A. Brighton, Chairman, Department of Mechanical Engineering, Michigan State University, East Lansing, MI 48824. Applications accepted until March 15, 1980. Michigan State University is an Equal Opportunity Employer.

## MEDICAL REPS

Experienced and Trainees. Many vacancies throughout the U.K.

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TELEPHONE 01-623 3912  
Ann Finlay, Bishopsgate Emp. Agcy., Ridgway House, 41 King William Street, London EC4R.

## LEICESTERSHIRE AREA MEDICAL PHYSICS DEPARTMENT MEDICAL PHYSICS TECHNICIAN III/IV (Radiation Physics) THE LEICESTER ROYAL INFIRMARY

Applications are invited for the above post to join a team of scientific and technical staff involved in the radiation physics aspects of the departments work.

The duties involve assisting in the fields of i) moulding work and the production of films for accurate beam alignment in radiotherapy treatment ii) the custody and use of sealed radioactive sources for radiotherapeutic uses and iii) some involvement with the planning of radiotherapy treatment and routine calibration procedures on treatment units.

The successful applicant will be qualified to at least ONC level and for grading of the technician III level will have had experience in at least one of the above categories, preferably section ii).

Salary scales:

Technician III £4330-£5511.

Technician IV £5552-£4764.

Further information may be obtained by contacting Mr J. I. Ratcliffe on Leicester 541414 ext 470.

Applications, stating age, qualifications and previous experience together with the names of two referees should be sent to: The Hospital Administrator, The Leicester Royal Infirmary, Infirmary Square, Leicester.

## THE MID KENT WATER COMPANY

### ASSOCIATE CHEMIST

Applications are invited for the above post which is based at the main laboratory in Snodland, Kent.

Candidates should have a degree or equivalent and experience in the Water Industry. A knowledge of GUC and A.A. equipment would also be an advantage.

The work is mainly associated with the analysis of water but the laboratory provides a broad based scientific service involving other expertise.

The appointment will be in accordance with NRC conditions and will be in Grade 5 or 6 of the NRC salary scale, i.e. £2421-£4236 p.a. In addition the Company operates a bonus scheme.

Written applications, including a curriculum vitae and the names and addresses of two referees, should be sent to: The Chief Scientist, The Mid Kent Water Company, P.O. Box 45, High Street, SNODLAND, Kent, NE13 3AH.

## BREWING RESEARCH FOUNDATION

Nutfeld, Redhill, Surrey

### A TECHNICAL OFFICER

is required to work on the analysis of beer and of the raw materials used by the brewing industry.

Candidates, up to the age of 25, should have HNC/HND in chemistry and some experience of working in an analytical laboratory.

Initial salary, on a scale which rises from £3500 to £4400, is dependent on qualifications and experience.

The Foundation offers pleasant conditions including 4 weeks annual holiday and a pension scheme.

Please write giving details of qualifications and experience to The Assistant Director, Brewing Research Foundation, Lyttel Hall, Nutfeld, Redhill, Surrey RH1 4HY.



## Applied Research: Flow Controls & Instrumentation

Solihull up to £10,492

The Midlands Research Station, situated at Solihull on the edge of Warwickshire countryside, is part of the Research and Development Division of British Gas which has gained a world-wide reputation in the areas of gas production, transmission and efficient energy utilisation.

A Principal Scientist/Engineer is required to take charge of a section of graduate scientists and engineers within the Controls Division of the Midlands Research Station. The Section has made a valuable contribution in the field of flow control equipment for industrial plant and industrial gas measurement. In order to exploit the opportunities offered by advances in micro-electronics, the work of the section is to expand to include the development of equipment to interface with micro-processor based systems which will be used increasingly to control industrial gas fired plant and processes.

The successful applicant (male or female) should have a good honours degree in a relevant scientific/engineering discipline and around 8-10 years post-graduate experience, at least 5 of which will have been in the research and development field, including experience and proven ability to lead other graduates.

Salary, depending on your experience, would be in a range starting at £8829 and rising to £10,492, plus the benefits of a large progressive organisation.

If you have the above qualifications and are interested in taking on a challenging opportunity please write or telephone, quoting reference MRS/283/NS to the Senior Personnel Officer (R & D), British Gas, 59 Bryanston Street, London W1A 2AZ.

**BRITISH GAS**



## Physics or Engineering Scientist

We are a highly successful international company, pioneering new technologies and products in the heat-recoverable plastics field, and utilising specialised polymer blend materials.

To develop our research capabilities further we are looking for a young scientist to be responsible for a number of product design and performance analysis studies. These will include thermal, stress and electrical models and could involve finite element methods of investigation as well as experimental work.

We have new research and development facilities, and our environment is informal, challenging and stimulating. We can offer an attractive salary, benefits and relocation package and excellent career development opportunities in the U.K., Europe and U.S.A. If you are currently earning up to c.£7,000 p.a. we would like to hear from you.

Please send a detailed C.V. or write/telephone for further details and an application form to:

## Raychem

Mike Evans, Personnel and Training Manager,  
Raychem Ltd., Faraday Road,  
Dorcan, Swindon, Wilts. SN3 5HH.  
Telephone: Swindon (0793) 28171.

### UNIVERSITY OF GLASGOW

ICI Ltd, Mond Division  
POSTDOCTORAL RESEARCH  
IN CHEMISTRY

Applications are invited for a Postdoctoral Research Assistant to investigate halogen exchange reactions in the presence of fluorinated transition metal oxides using radiotracer methods. The work will be carried out at Glasgow in collaboration with Drs G. Webb and J. M. Winfield and the post is tenable for two years. Starting salary (Research and Analogous Staff Scales, Range 1A) will be £4335 or £4622 (under review) plus USS, depending on qualifications and experience. The starting date will be by mutual agreement.

At the conclusion of the University appointment it is expected that the Research Assistant will take up an appointment with ICI Ltd, Mond Division.

Applicants, giving a curriculum vitae and the names of two referees, should be sent as soon as possible to Dr J. M. Winfield, Department of Chemistry, University of Glasgow, Glasgow G12 8QQ, from whom further particulars may be obtained.

In reply please quote ref no 4569N.



## QUEEN'S MEDICAL CENTRE

CITY HOSPITAL

### SENIOR PHYSICIST - INSTRUMENTATION

To be responsible for the Medical Physics Department's involvement in the development and maintenance of electronic instrumentation. Applicants must have experience of collaborating with clinical and service departments. A good working knowledge of modern electronics is essential and should preferably include microprocessor applications.

Salary: £6711 rising by annual increments to £8952 p.a.

Further information from:  
Dr J. H. Todd on Nottingham 603111 ext. 2757.

Application forms from: Mr J. A. Williams,  
Administrator, Personnel Services,  
University Hospital, Queen's Medical  
Centre, Nottingham.

Closing date: 2 February

**SOUTH NOTTINGHAM HEALTH DISTRICT**

Nottinghamshire Area Health Authority(T)



### UNIVERSITY OF NEWCASTLE UPON TYNE Building Science Section School of Architecture

Applications are invited for two  
RESEARCH ASSOCIATES/  
SENIOR RESEARCH  
ASSOCIATES

to work on an SRC sponsored project to investigate the relationship between the performance of heat pump systems and the energy requirements of highly insulated dwellings. The aim of the study will be to optimise the house and heat pump system, having taken into account factors such as climate, building performance and user requirements.

Applicants should have a background in either the engineering and evaluation of environmental systems or computer simulation techniques. Proven research experience is required and applicants should have a PhD or equivalent qualifications.

The project is for three years, starting 1 April 1980. Commencing salary will be in the range £4335-£6032 depending on age, qualifications and experience and includes membership of USS.

Further information may be obtained from Prof A. C. Hardy, Building Science Section, School of Architecture, The University, Newcastle Upon Tyne NE1 7RU. Tel: 0632 28511, ext 2007.



THE ROYAL VETERINARY COLLEGE  
University of London  
Department of Medicine  
Hawkshead Lane, North Mymms, Herts.

## TECHNICIAN GRADE 4

required for the Microbiology Laboratory of the department's diagnostic services. The daily work is mainly bacteriological with some mycology and parasitology.

Applicants should have some years relevant laboratory experience and preferably possess a related advanced certificate, but consideration will be given to intermediate qualified staff studying for an advanced examination in microbiology techniques.

Salary scale: £4487 to £5046 pa (including London Allowance)

Pleasant rural surroundings; good working conditions; 5 weeks holiday; superannuation scheme.

For further details please phone G. W. Swayne, Potters Bar 5468.

Applications in writing to Assistant Secretary (Personnel) The Royal Veterinary College, Royal College Street, London NW1 1TU (01-367-2838 Ext. 254)

## UNIVERSITY OF BIRMINGHAM

Department of Geological  
Sciences

### LECTURER IN HYDROGEOLOGY

Applications are invited for the above post, the duties of which will principally include the teaching of Hydrogeology at MSc Course level and the supervision of Course project work. The successful applicant will be expected to pursue research in the field of hydrogeology.

Applicants should have a good honours degree. A postgraduate qualification in Hydrogeology and practical experience would be advantageous.

Salary, according to age and experience, will be in the range £4335-£5662 plus superannuation.

Further particulars are available from the Assistant Registrar, Science and Engineering, University of Birmingham, PO Box 365, Birmingham B15 2TT, to whom applications (three copies) including curriculum vitae and naming three referees should be sent by Friday, 15 February, 1980.

Please quote ref NSG3(r).

## UNIVERSITY OF NOTTINGHAM

Department of Electrical and  
Electronic Engineering

Theoretical analysis of optical  
fibre waveguide

### RESEARCH ASSISTANT

A vacancy has arisen in connection with studies of wave propagation in optical fibre waveguide, supported by the Post Office Research Centre, and tenable for one year in the first instance.

Applicants should have a good honours degree and a PhD in Electronic Engineering, Theoretical Physics or Applied Mathematics. We are a group concerned with numerical and analytical methods of solving wave propagation problems in electromagnetic wave knowledge of modern techniques in other areas of Theoretical Physics would also be valuable.

Salary in the range £4335-£5199, to start as soon as possible.

For further details contact: Dr J. M. Arnold, Department of Electrical and Electronic Engineering, University of Nottingham, Nottingham NG7 2RD. Tel: Nottingham 56101, ext 2225.

## Johnson Matthey Research Centre

At our Research Centre near Reading, we play a key role in the future of the Johnson Matthey Group by providing effective research. As a Group we have interests in the manufacture of a wide range of engineering materials, electronic products, chemicals, catalysts, pigments and ceramic colours from precious and base metals.

We are seeking to fill the following vacancies:

## Electron Probe Microanalyst

Suitable for a graduate with experience of electron probe X-ray microanalysis. He or she will be required to provide a service in electron probe analysis to the Research Centre using a recently purchased Camebax instrument with wave length and energy dispersive spectrometers and full automation. Encouragement will be given to exploit the full potential of the latest developments in microprobe analysis in its application to the range of materials and products of interest to the Group.

## Information Scientist

To join a small team providing technical intelligence, library and forward planning services to the Research Centre and to the Group, offering opportunities to work on projects covering a wide field of scientific disciplines. We are looking for graduates in the physical sciences who have a broad scientific background and preferably a qualification or experience in information science. They should have the ability to analyse technical and commercial data and be able to write clear, concise reports.

These appointments offer interesting and rewarding work under excellent conditions in a modern research centre.

Please write, with career details, to L. A. Ford, Johnson Matthey Research Centre, Blounts Court, Sonning Common, Reading, Berkshire RG4 9NH.



## ELECTRONICS ENGINEER/ ACCELERATOR OPERATOR

for 4MV Van de Graaff

to assist with operation, maintenance and development of this unique, multi-purpose machine recently installed at the Gray Laboratory for research aimed at improving radiation treatment of cancer. Support facilities include electronics and mechanical workshops, PDP 11 computer. Candidates preferably with HNC degree and relevant experience. Starting salary on scale rising to £7494 pa.

Information and application form, in confidence, from: Deputy Director, Cancer Research Campaign Gray Laboratory, Mount Vernon Hospital, Northwood, Middx. HA6 2RN. Tel: Northwood 28611.

## UNIVERSITY OF SUSSEX School of Mathematical and Physical Sciences RESEARCH FELLOW IN PHYSICS

Applications are invited for the position of postdoctoral Research Fellow in a programme of experimental research concerned with the study of light-ion irradiation and implantation effects in semiconductors. The work will use the Sussex 3MV Van de Graaf accelerator, and will include use of existing facilities for channelling and electrical measurements on semiconductors. The successful applicant will be expected to contribute fully to the initiation of appropriate experiments and to be able to give advice and help research students working on related projects.

The post is available for up to 2½ years from 1 February, 1980, at a salary on the grade 1A scale which from 1 April, 1980, will be £5052-£6789 (under review). The work is supported by a Science Research Council grant to Dr D. W. Palmer.

Applications, including a curriculum vitae and names and addresses of two referees, should be sent to Dr D. W. Palmer, School of Mathematical and Physical Sciences, University of Sussex, Brighton BN1 9QH, from whom further information may also be obtained.

ALBERT-LUDWIGS-  
UNIVERSITÄT  
7800 FREIBURG, W. GERMANY

## Associate Professor of Theoretical Atomic and Molecular Physics

At the Faculty of Physics of the Albert-Ludwigs-Universität the position of Professor of Theoretical Atomic and Molecular Physics will soon be available.

The applicant is expected to participate in research and teaching, to work with experimentalists, and to learn German.

Applications including a statement of research interests, publications list, curriculum vitae and names of three professional referees should be sent to the Dekan der Fakultät für Physik, Universität Freiburg Hermann-Herder-Strasse 2, D 7800 Freiburg, West-Germany, to arrive not later than 31 March, 1980.

## MEDICAL RESEARCH COUNCIL

### BRAIN RESEARCH

Application is invited for a Medical Research Council post at the Research Officer level in a group investigating cerebral evoked potentials in man, and the application of these techniques in clinical neurology and psychiatry. The work would involve the recording and analysis of evoked potentials in patients and healthy controls, including on and off-line computer analysis of the data, and would also involve the care and maintenance of electronic equipment. The post offers considerable scope for someone with an interest in joining a team actively engaged in fundamental and applied research in this field. Candidates should be adaptable. Terms and conditions on MRC scales in accordance with age, qualifications and previous experience.

Applications, stating age and experience and giving the names of two referees, should be sent to Dr A. M. Halliday, Institute of Neurology, National Hospital, Queen's Square, London WC1. Closing date 15 February, 1980.

CAMBRIDGE UNIVERSITY PRESS



# Science Desk Editor

The School and Further Education section of Cambridge University Press requires as soon as possible a Desk Editor to work on a rapidly growing list of science textbooks.

The successful applicant should have a degree in the Physical Sciences (Physics and/or Chemistry) and a knowledge of Biology would also be useful. At least one year's editorial experience in schoolbook publishing is required and teaching experience is desirable but not essential.

This post offers the chance to join an exciting and rapidly expanding publishing group and the work will involve all aspects of book production from an early stage. The successful applicant will become quickly involved in important decision making and there will be ample opportunity to use initiative and new ideas.

Salary is on a scale from £4737-£6453. Four weeks annual holiday.

Please write giving full details of education and previous experience to:—

Mrs Jenny Jullien,  
Personnel Manager,  
Cambridge University Press,  
PO Box 110,  
Cambridge  
CB2 3RL

## RESEARCH OFFICER

SOUTH MANCHESTER

Salary £4530 - £10,705 pa.

The Central Electricity Generating Board requires a RESEARCH OFFICER at its N.D.T. Applications Centre which is located in the Scientific Services Department at Wythenshawe.

This N.D.T. Applications Centre has a national responsibility within the CEGB for research and development of non-destructive testing methods. These are principally ultrasonic techniques though electromagnetic methods are also under study.

Many of the projects, particularly those concerned with automatic ultrasonic testing, require the parallel development of analogue or digital electronic systems, a considerable amount of work on test data storage, treatment and display is involved.

The post demands an enthusiastic physicist or electronics engineer to carry out such electronic developments.

A good honours degree in either applied physics or electronics is desirable, whilst experience and expertise in both analogue and digital system development is required.

Applications in writing, from either sex, on standard application form obtainable from the Personnel Manager, CEGB, North Western Region, Europa House, Bird Hall Lane, Cheshire Heath, Stockport, Cheshire, SK1 0XA to reach him no later than 1 February, 1980. Please quote reference 179/NS



St. Mary's Hospital Medical School  
(University of London)  
London W2 1PG

Department of Biochemistry

## RESEARCH ASSISTANT

required immediately to join research group applying recombinant DNA techniques to inherited diagnosis of thalassemias and other genetic diseases. One year in first instance, may be renewable for further three years. Commencing salary within scale £3776-£4533 + £100 as London Allowance (basic salary has 10% increase pending). Successful candidate should either have experience with recombinant DNA and molecular biology techniques or a relevant Honours degree, with motivation and ability to work hard. Enquiries to Dr Derek Wood, Dept of Biochemistry (Tel. 003 723 1352 Ext 50). Applications with full curriculum vitae and names and addresses of two referees to The Secretary at above address by 15 February quoting Ref RA/B/DW

Gallenkamp, a leading company in the scientific equipment field, and a member of the Fisons Group.

## Electronic Development Technician

We have a vacancy for a Technician in our Development Department, where a team of engineers and scientists design and develop mechanical and electro-mechanical laboratory apparatus and measuring instruments.

Two years' experience in electronics is desirable preferably in a Development Department. An Electronic Technician Certificate or ONC in Electrical Engineering would be helpful.

The job is located in a modern well-equipped laboratory in our head office building near to Moorgate and Liverpool Street stations. 4 weeks holiday, subsidised staff restaurant, other benefits are as associated with a large Company.

Please phone 247-3211 extn 285, or write to S. Bramble (Mrs), Recruitment Officer, A. Gallenkamp and Co. Ltd., P.O. Box 290, Technico House, Christopher Street, London EC2P 2ER.

# Gallenkamp

UNIVERSITY OF SHEFFIELD  
CLINICAL SCIENCES CENTRE  
(NORTHERN GENERAL HOSPITAL)

## TECHNICIAN (Grade 3)

required to provide technical support on a research project concerned with Cellular Immunology and Tissue Culture. Some relevant experience in this field would be desirable.

Salary on scale £3372-£3840 p.a. (under review).

Please write stating qualifications, experience and the names of two referees to the Administrative Officer (Personnel) (Ref. S 1455/NS), The University, Sheffield S16 2TN.

## BLOOD GROUP REFERENCE LABORATORY SCIENTIFIC OFFICER

Salary range from £4,335-£5882

This laboratory acts as a Central Reference Laboratory for the National Blood Transfusion Service. It is also a producer of blood grouping reagents for use in Transfusion Centres and Hospital Blood Banks. A graduate is sought for work related to the production of monoclonal antibodies of blood group specificity. The work will be based initially at the Laboratory of Molecular Biology, University Medical School, Cambridge.

Further information can be obtained from Dr. A. M. Holburn 01 730 2152

Application in writing with details of experience and the names of two referees to: Miss K. Lomas, Blood Group Reference Laboratory, Gatlin Road, off Eddisbury Road, London SW1W 6JL

WELSH NATIONAL SCHOOL OF MEDICINE  
(University of Wales)  
Department of Haematology

## RESEARCH TECHNICIAN

required to join a small team investigating biochemical and immunological aspects of blood coagulation mainly concerning factor VIII and its abnormality in haemophilia and related disorders. Science graduate, I.M.L.S. or H.N.C. Research experience not essential. Salary on the scale for University Technical Staff Grade 4 up to £3,927 per annum (under review). The appointment will last until 30 November 1981.

Further particulars and application forms (quoting ref. No. W04/2/80) available from the Registrar and Secretary, Welsh National School of Medicine, Heath Park, Cardiff (Tel. No. 0222 759444 ext. 2296). Closing date for application 7 February, 1980.



## Technician Careers in Pharmaceutical Formulation Greenford

Our Pharmaceutical Formulation Department carries out research and development associated with new and established compounds and their formulation into products for human and veterinary use world wide.

We have a number of vacancies for technicians. The work is varied, involving design and preparation of experimental formulations of a complete range of pharmaceutical products together with investigation of manufacturing processes packaging. The work is arranged within small teams, managed by graduate staff, principally pharmacists.

Applications are invited from technicians holding Apothecaries Hall or City and Guilds Dispensing Certificates or Diploma in Formulation, who have an aptitude for practical work and who wish to pursue a career in laboratory work. Comprehensive training will be an important stage in the development of such a career, and will be provided.

The Company offers excellent conditions of employment, including a non-contributory pension scheme and bonus scheme and an excellent sports and social club.

Please write or telephone for an application form to:- Mrs. C. A. Carter, Personnel Officer, Glaxo Group Research Ltd., Greenford Road, Greenford, Middlesex. Tel: 01-422 3434, ext 11, quoting ref. no. AQ.293.

# Glaxo Group Research Ltd.

### H. B. BERRIDGE & PARTNERS Environmental Consultants

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Applications are invited for the post of Chief Analyst to a small independent Laboratory in Chelmsford, Essex specialising in all aspects of Water Pollution.

Candidates must have the following minimum qualifications:

1. A.R.I.C.
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3. Must be car driver.
4. Must have had several years experience of complex responsibility for an analytical laboratory.

Salary not less than £7500 per annum plus various benefits such as BUPA membership. Four weeks annual leave.

Applications with complete career details in writing to Mr H. B. Berridge at 104 Eaton Place, London SW1.

### UNIVERSITY COLLEGE HOSPITAL MEDICAL SCHOOL

#### Department of Morbid Anatomy

A vacancy has arisen for a JUNIOR MEDICAL LABORATORY SCIENTIFIC OFFICER

In this busy department which has recently moved into new laboratories. Day release is given for further study. Whitley Council conditions are in operation. Please apply in writing stating age, experience and relevant qualifications to the Secretary, UCH Medical School, University Street, London WC1E 6JJ, giving the names of two referees and quoting reference MA/JT.

## Pharmacists/Chemists Pharmaceutical Development

Beecham Pharmaceuticals is a major British Company with a reputation for high quality original work supported by an impressive research and development budget.

There are vacancies in our Formulation Department for registered Pharmacists, with or without industrial experience, and for Chemists preferably with some experience in the analysis or manufacture of pharmaceutical products. This department has been specially designed for the purpose and is responsible for converting drug substances into medicinal dosage forms. Successful applicants will join teams working in the whole field of pharmaceutical technology and will be involved with the development of new drugs from the pre-formulation stage to scale-up for manufacture.

Based at the new Biosciences Research Centre situated in pleasant surroundings near Epsom Downs, we offer first class working conditions, a non-contributory pension scheme, free life insurance and flexible working hours.

For an application form please telephone or write to the Site Personnel Manager, Beecham Pharmaceuticals Research Division, Biosciences Research Centre, Great Burgh, 1 Yew Tree Bottom Road, Epsom, Surrey. Tel: Burgh Heagh 53344 Ext: 2207. Closing date: 2 February, 1980.

# Beecham Pharmaceuticals

### UNIVERSITY OF SOUTHAMPTON

#### Institute of Sound and Vibration Research Structural Dynamics RESEARCH ASSISTANTS/ FELLOWS

are required to carry out research on the following topics.

**Structural Vibration**  
The mechanisms governing the vibration of rolling discs with a substructure are to be examined theoretically.

**Acoustic Emission**  
Acoustic emission from carbon fibre reinforced plastics during fatigue is to be studied. The work will be largely experimental in nature and will involve signal processing. Suitably qualified candidates will be encouraged to register for a higher degree.

Salaries in range £4000-£5700 per annum. USS benefits.

Applications in duplicate, giving the names of two referees and details of qualifications and experience, should be sent to D. A. S. Copland, The University, Southampton SO9 5NH, quoting reference 231/R/NSC.

### THE ROYAL VETERINARY COLLEGE University of London Division of Clinical Studies DEPARTMENT OF MEDICINE

## RESEARCH ASSISTANT

Collaborative research in neurological disorders associated with traumatic myelocystitis in progress at The Royal Veterinary College and Imperial College. A research assistant is required to participate in the programme which would involve the measurement of pharmacological and physiological parameters following in vivo administration of toxins.

Applications are invited from veterinarians or postgraduates in pharmacology, physiology or chemical pathology. The appointee will be required to work at The Royal Veterinary College Field Station, near Putney Bar, Herts, and at the Biochemistry Department, Imperial College.

The post is funded by the Wellcome Trust for two years and may be taken up immediately. Salary will be related to qualifications and experience.

Application form from the Assistant Secretary (Personnel), The Royal Veterinary College, Royal College Street, London NW1 1TU (tel: 01-275 3323).

CLOSING DATE FOR APPLICATIONS: 31 January 1980.

### KING'S COLLEGE HOSPITAL ASSISTANT PHYSICIST (R/T)

Applications are invited for the post of Basic Grade Physicist in the Department of Medical Physics. The successful applicant will work mainly on radiotherapy physics under the direction of a Senior Physicist, but there will be opportunities to undertake further training or if appropriate to read for a higher degree. Candidates must possess a degree in Physics and research, in support of clinical and teaching in the Hospital. The person appointed will be encouraged to undertake further training or if appropriate to read for a higher degree. Candidates must possess a degree in Physics and previous experience in radiotherapy physics, though not essential, would be an advantage.

Salary scale: £4205-£5714 inclusive depending on qualifications and experience.

For application form and job description contact: Sector Administration, King's College Hospital, Denmark Hill London SE5 8RS. Tel: 01-274 6222 ext 2408.

Please quote ref. No. SA/71. Closing date: 14 February, 1980.



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## APPLIED MATHEMATICIANS

To work in the areas of vibration, acoustics, fluid mechanics and theoretical oceanography. Research experience (PhD or equivalent), theoretical or experimental, would be a decided advantage.

Salary negotiable, but generous informal working conditions in the centre of Cambridge. Applications with curriculum vitae and names of two referees to Mr Jack Lang, Topeexpress Ltd., 1 Portland Place, Cambridge, CB5 8AF.

## MATERIALS RESEARCH

The Refractories Section of BGIRA requires a graduate or equivalent (preferred age 23-32) to study high temperature reactions of refractories with glasses at furnace atmospheres. The work involves laboratory studies of the corrosion of refractory oxides and measurements of the corroding environment in commercial furnaces.

Knowledge of the industry will be acquired in training; experience of the industry is not a requirement for application.

Applications should be in writing to: Mrs Mollie Peck



The British Glass Industry Research Association  
Northumberland Road, Sheffield, S10 2UA.

## GLASGOW COLLEGE OF TECHNOLOGY

The Glasgow College of Technology, a major polytechnic institution of higher education, invites applications for the following post.

## PHYSICS LECTURER 'A'

Applicants should have a good honours degree with industrial and/or post graduate experience in physics or physical electronics.

### Salary Scale:

LECTURER 'A' £4464-£7821 (BAR) £8397

Placing on the salary scale will be given for relevant experience. Forms of application and further particulars can be obtained from the Establishments Officer, Glasgow College of Technology, Cowcaddens Road, Glasgow G4 0BA, and should be returned within 14 days of the appearance of this advertisement.

Edward Miller, Director of Education,  
STRATHCLYDE REGIONAL COUNCIL.

## THE POLYTECHNIC OF CENTRAL LONDON

School of Engineering and Science  
**RESEARCH ASSISTANT  
(CARBON FILTERS)**

Salary: £3201-£3909 inclusive of London Allowance.

Required to work on project into Stress Analysis in Fibre Reinforced Composite Materials. A working knowledge of computer methods would be an advantage. There are various projects in Bio-Engineering available.

Closing date: 5 February, 1980.

Application form and further details from the Establishments Office, PCL, 30 Regent Street, London W1R 3AL. (Tel. 01-586-3021 ext. 212).

## MANCHESTER AREA HEALTH AUTHORITY LTD.—SOUTH DISTRICT

WYTHENSHAW HOSPITAL,  
MANCHESTER M23 9LT

## SENIOR BIOCHEMIST

Required in this laboratory which serves a District General Hospital and Regional Cardiothoracic Centre. Experience in general biochemistry is essential and an interest in R.I. work or computers would be considered an advantage.

Applications with full particulars to the Consultant Pathologist in Charge.

## MEMORIAL UNIVERSITY OF NEWFOUNDLAND

Department of Geology

Applications are invited for a

faculty position in the new  
**METAMORPHIC PETROLOGY**  
commencing 1 July, 1980 or as soon as possible thereafter. Candidates must be strongly field-oriented and committed to establishing a research programme in Labrador. Teaching duties will include senior undergraduate and graduate level courses in petrographic, kinetic and thermodynamic aspects of metamorphic petrology. Applications at any rank will be considered, but the successful applicant must hold the PhD degree at the time of appointment.

Applications, which must include a detailed curriculum vitae and the names and addresses of three referees, should be sent by 15 March, 1980 to Dr D. Skevington, Head, Department of Geology, Memorial University of Newfoundland, St John's, Newfoundland, Canada A1B 3X5 (telephone: (709) 793-1200, ext 3142/5). From 1980, further particulars can be obtained,

## ROYAL POSTGRADUATE MEDICAL SCHOOL

Department of Histochemistry  
**SCIENTIFIC OFFICER**

required with experience in electron microscopy and basic knowledge of histology to assist in running small unit. Opportunity for research in neuroendocrinology. Initial appointment for nine months with good possibilities for extension.

Salary negotiable, up to £5000 (annual equivalent).

Applications in forms and further particulars may be obtained from the Personnel Officer, Royal Postgraduate Medical School, 150 Du Cane Road, London W12 0HS, quoting reference number 6/239/NS.

## POTATO MARKETING BOARD EXPERIMENTAL STATION, SUTTON BRIDGE

SPALDING, LINCOLNSHIRE

## AN ASSISTANT EXPERIMENTAL OFFICER

is required to join a small team concerned in a programme covering all aspects of the relationship between the potato and the marketing of potatoes. An aptitude for scientific and experimental work is necessary and relevant academic qualifications would be an advantage. Some field work and contact with growers. Contributory Pension Scheme. Good accommodation available. Commercial salary c. £4,000 a.p. on a scale rising to £5,000.

Application form from Personnel, Potato Marketing Board, Sutton Bridge, Lincolnshire, Spalding, Lincolnshire, S11 9NB.

## LAKE DISTRICT

Bright young person required for kitchen duties and general housework in friendly informal atmosphere in residential centre running courses for young people. No experience necessary but an interest in outdoor pursuits an advantage. Full board and accommodation provided, 1½ days off per week, six weeks' annual holiday. Full details of past and present employment together with telephone number if possible please to Gerry Heale, Brathay Hall, Ambleside, Cumbria.

## BUREAU TECH (SCIENTIFIC STAFF AGENCY)

Top jobs for ONCHNC/HND/AI/MLT BSc. (Chem; Phys; Biol; Med. Lab. subjects; Electronics and Metallurgy.) Immediate vacancies for Paint, Ink and Surface Coating Technologists. We find you the job free of charge. Tel: 01-959 3517.

## FRIENDS OF THE EARTH BIRMINGHAM

We are looking for environmentally committed people to join our cooperative of 16. The job involves practical insulation and draughtproofing, research into energy conservation and production of information material. No experience necessary but an ability to work hard and flexibly are needed. Write for further details as soon as possible to FOE Brum, 54-57 Allison St, Digbeth, Birmingham 5.



**PIRA** The Research Association for the Paper and Board, Printing and Packaging Industries

## Do you have a Degree or HND in Physics or Engineering?

We are looking for a person who can put their qualifications to a practical use by applying their knowledge to analysing problems.

Our Packaging Division needs a person to take responsibility for finding solutions to our clients problems and reporting on the work undertaken.

The work would involve site visits in the UK and a driving licence is therefore necessary.

Salary in the range £4963-£7195 (bar £6205) according to age and experience and qualifications.

Please telephone for an application form: The Personnel Officer, Pira, Randalls Road, Leatherhead KT22 7RU. Tel: Leatherhead 76161 quoting ref: PK/PL/779.

THE  
MATHILDA AND TERENCE KENNEDY  
INSTITUTE OF RHEUMATOLOGY

POST DOCTORAL  
RESEARCH ASSISTANT  
in  
DIVISION OF  
CLINICAL IMMUNOLOGY

Applications are invited for a Research Assistant to investigate the possibility that rheumatoid arthritis arises from abnormal regulation of tolerance of B cells to auto-antigens. This post offers the opportunity for independent work within the overall aims of the Division (Head: Dr R. M. Main). Candidates should have a PhD in biological sciences. Good knowledge of immunology, essential and experience in immunocytochemical and/or cellular immunological techniques desirable. This project is funded by the Nuffield Foundation for three years. The salary will be based on Range 1A of the University of London scales for Research and Academic Staffs. The successful applicant will be expected to start work as soon as possible. Applications in writing, including curriculum vitae and names of two referees should be made to the General Secretary, The Mathilda and Terence Kennedy Institute of Rheumatology, Ryle Gardens, Hammersmith, W6 7DW.

### X-RAY TECHNICIAN (Grade 3)

required in Department of Geology, University of Reading, to work on X-ray diffraction and X-ray fluorescence analysis of rocks and minerals. Previous experience in similar analytical techniques an advantage but not essential. ONC or equivalent qualification required, and some knowledge of electronics useful. Salary in scale £3122-£3553 per annum (under review). Apply for further details quoting Ref T.S.80A to Assistant Bursar (Personnel), University of Reading, Whiteknights, Reading RG6 2AH.

### Does North Devon appeal to you?

Would you like to be part of a development laboratory team?

If so, read on!

We are INTERNATIONAL CHEMICAL COMPANY LIMITED the manufacturers of such brand leading pharmaceutical and toiletry preparations as "ANADIN", "BISODOL", "ANNE FRENCH" and "IMMAC" and we are located in one of the most attractive parts of North Devon, close to Exmoor National Park and within a few minutes drive of beautiful coastline and beaches.

We are looking for an enthusiastic person, preferably with some experience in pharmaceutical and toiletry product development, and with such chemical qualifications as a BSc, MRIC or equivalent to join our Laboratory as a

### DEVELOPMENT CHEMIST

The work will involve the formulation of new Pharmaceutical and Toiletry preparations and the re-formulation of existing products for both the home and overseas markets. This would include the follow through of these products from the Laboratory to pilot scale quantities and on to the manufacture of batches of the products.

In addition, we can offer you pleasant working conditions, 4 weeks holiday each year, subsidised canteen, staff sales and Contributory Pension scheme.

If you feel that you meet these requirements please write to the Director of Personnel:—



International Chemical Company Limited,  
Wrafton,  
BRAUNTON,  
N. Devon EX33 2DL  
For an application form.

## Metallurgical Chemist London

Our client is a leading specialist in the manufacture of white metal alloys, based on tin and lead, and in bearing engineering and repair.

As Metallurgical Chemist, reporting to the Technical Manager, you will be responsible for the day to day running of the chemical laboratory, which is approved by the MoD to DEF STAN 05-32.

Your specific duties will include the provision of a rapid analytical service to the company's foundry and engineering departments, to its subsidiary companies and local industry. You will be involved in developing new markets for the laboratory's services and will therefore be required to devise analytical methods consistent with 05-32 approval.

Candidates, male or female, will need HNC or equivalent and some years of analytical experience. An attractive salary is negotiable, according to age and experience, and entry to the group's bonus and pension schemes comes after 12 months' service. Benefits include 4 weeks holiday and subsidised staff canteen.

Contact: Jackie Smith (01) 235 7030  
Ext 210. (Answering service out of  
hours [01] 235 6938). PER, 4/5  
Grosvenor Place, London SW1X  
7SB.

Applications are welcome from  
both men and women

**PER**  
Professional & Executive  
Recruitment

## UNIVERSITY OF OXFORD

## OXFORD ORTHOPAEDIC ENGINEERING CENTRE

## RESEARCH BIOENGINEER

A research worker is required to conduct studies primarily in the area of the interface between the skin and the supporting surfaces, with particular reference to the distribution of pressure beneath the foot, or beneath subjects seated in a wheelchair. The candidate should be a graduate in engineering or physics, and would preferably have experience of research in a medical field. Depending on qualifications and experience, the successful candidate would be appointed as either Research Officer or Research Assistant.

## ELECTRONICS DESIGNER/TECHNICIAN OR PHYSICIST

This post offers an opportunity for an engineer or physicist with a degree interest in medical engineering. The appointee would assist with the design and construction of a wide variety of instruments for bioengineering research. Projects currently include computer/television interface, and patient monitoring packages. The appointment will involve working with medical and scientific staff in both the Nuffield Orthopaedic Centre and the Department of Engineering Science of the University of Oxford. Candidates should possess an HND or a degree in physics or electronic engineering. Appropriately qualified candidates would have the opportunity to undertake research leading to an MSc degree.

## ENGINEERING DESIGNER

Applications are invited for the post of Research Assistant to work on the design and practical development of aids and test equipment for research into orthopaedic disorders and their treatment. The position offers considerable opportunity for initiative. Applicants should be experienced in workshop and drawing office procedures and be prepared to carry out detail design work and collaborate with clinical staff. It is an opportunity for a younger man who wishes to gain experience in medical research.

Appointments to these posts will be for an initial period of three years, which is renewable subject to the contractual arrangements for the Centre.

The salary range is £5775-£6355 (under review), depending on age, qualifications and experience.

Applications should be submitted by the 18 February, 1990.

Further details are available from

J. D. Harris, Director,  
Oxford Orthopaedic Engineering Centre,  
Nuffield Orthopaedic Centre,  
Headington, Oxford, OX3 7LD.  
Tel: 0885-64811, ext. 514/910.

Trainee/Assistant  
Information Officer

An excellent opportunity has arisen at our offices at Ruislip Road, Southall for a young person to train within the information services section of our design and research department.

The section provides a comprehensive technical library and information service, fully utilising the extensive computer facilities available.

Full training will be given including a high degree of computer programming, enabling the successful candidate to eventually play a full part in the running of the section.

Applicants should have a sound science background, to at least 'A' level but possibly degree standard, in addition to the logical and methodical approach so necessary when using computer systems.

This is a progressive position offering an attractive salary and fringe benefits that include free travel to and from Hayes, Ruislip, Harrow and Ealing, a subsidised restaurant and an extensive sports and social club.

For more information and an application form please contact David Nelson, (Ref AAK) Personnel Department, Taylor Woodrow Construction Limited, 345 Ruislip Road, Southall, Middlesex UB1 2QX. Tel: 01-575 4894.

Construction

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## SECRETARY

Required by the Classified Advertisement Manager of New Scientist and New Society. The successful applicant will be 20+, intelligent, cheerful and energetic. Good typing and shorthand speeds are essential, as is a pleasant telephone manner as there will be considerable contact with clients and advertising agencies. An aptitude for figures would also be an advantage. The offices are new and situated within easy reach of Oxford Street. The salary is good and luncheon vouchers are provided. Please telephone on 01-404 0700 or write to:

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1-19 New Oxford Street  
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UNIVERSITY OF BRISTOL  
WELLCOME COMPARATIVE  
ANAESTHETIC LABORATORY

## Department of Veterinary Surgery

Applications are invited for a

## BASIC SCIENTIST

to participate as a Research Assistant in a study of the uptake and distribution of inhaled anaesthetics in large animals.

Applicants must have an interest in computer programming and modelling.

The appointment is for two years and the starting salary will be up to £3333 per annum. (Scale under review).

Further information can be obtained from, and applications with the names of two referees should be sent to: Dr B. M. G. Weaver, Wellcome Comparative Anaesthetic Laboratory, Department of Veterinary Surgery, Langford House, Langford, Bristol BS18 7DU.

## TECHNICIAN

(Grade 3)

required in Departments of Physiology & Biochemistry and Zoology, University of Reading, to work under supervision in small well equipped mechanical engineering workshop, producing items in a variety of materials such as metals, plastic and wood for teaching and research. Some practical experience of basic workshop techniques essential. Salary in scale £3122-£3553 per annum (under review). Apply with names of two referees quoting Ref. T.S. 03A to Assistant Bureau, (Personnel), Whiteknights, University of Reading, Reading RG6 2AH.

MONASH UNIVERSITY  
AUSTRALIADepartment of Biochemistry  
SENIOR TUTOR

Applicants should have a PhD or equivalent qualifications, or be about to complete a PhD. The position will involve limited undergraduate teaching duties, and the successful applicant will actively participate in the on-going research program of Professor A. W. Linanne and colleagues on the biogenesis of yeast mitochondria. Preference will be given to applicants with practical experience in the field of molecular biology, particularly those techniques used in nucleic acid studies and membrane biology. Salary \$A14 041-\$A16 085 per annum. Superannuation. Travelling and removal allowance. Temporary housing assistance. Applications including Ref. No. 30213, curriculum vitae and three referees to the Academic Registrar, Monash University, Clayton, Victoria 3168, Australia, with copy to Association of Commonwealth Universities (Appts), 36 Gordon Square, London WC1H 0PF by 29 February, 1990.

## TECHNICIAN

Grade 2B

required by Department of Pharmacology to work in the interdisciplinary subject of immunopharmacology. Experience in immunological and pharmacological techniques is an advantage. Salary in range £3717-£4122 inclusive of London Weighting. Five weeks annual paid holiday plus statutory and customary days. Application form from Personnel Officer (Technical Staff - FE14), University College London, Gower Street, London WC1E 6BT.



**CRANFIELD  
INSTITUTE OF TECHNOLOGY  
FLUID ENGINEERING UNIT  
RESEARCH OFFICER**  
to work with  
**DISABLED TECHNOLOGISTS**

An experienced Engineer/Applied Mathematician/Physicist is needed to set up and run a special unit for a small number of disabled technology graduates. The project, funded by the Nuffield Foundation, aims to provide work appropriate to the academic ability of the physically disabled participants, and eventually to produce a self-financing unit able to take on industrial contracts in open competition.

The disciplines of the participants are expected to be those in which the computer is a major tool, and the Research Officer will need to have interests in computational methods relevant to industrial fluid mechanics and an understanding of the problems of the disabled.

Salary on a scale up to £6066 (under review) according to age, experience and qualifications. This is a two-year post in the first instance.

Further details and application form from: Professor R. C. Baker, Head of Fluid Engineering Unit, Cranfield Institute of Technology, Cranfield, Bedford MK43 0AL.

**Agricultural Science Service, ADAS,  
Harpden Laboratory**

## Chemist/Biologist

- ☐ Join Pesticides Registration Department where the major concern is the safe and effective use of pesticides, including herbicides in crop protection
- ☐ Provide technical support to the Pesticides Safety Precautions Scheme
- ☐ Assess applications for the safety clearance of pesticides
- ☐ Advise and negotiate with agro-chemical manufacturers
- ☐ Prepare technical papers for presentation to scientific committees
- ☐ Liaise with other government departments, local authorities and research organisations.
- ☐ Honours degree or equivalent in Chemistry or appropriate biological subject
- ☐ At least 2 years relevant postgraduate experience essential
- ☐ Age under 30
- ☐ Appointment as Higher Scientific Officer (£5095 - £6735)
- ☐ Ref: SB/5/AL
- ☐ Application forms (for return by 8th February, 1980) from Civil Service Commission, Alencon Link, Basingstoke, Hants, RG21 1JB, or telephone Basingstoke (0256) 68551 (answering service operates outside office hours).

Ministry of Agriculture, Fisheries and Foods.

## Science Group

CIVIL SERVICE

**MEDICAL LABORATORY  
SCIENTIFIC OFFICER**

required as soon as possible to work for three to four years in a research orientated Virology Department in London. Salary according to age and experience. Apply: The Secretary, St Mary's Hospital Medical School, Paddington, London W2 1PG.

### STUDENTSHIPS

**UNIVERSITY OF  
CAMBRIDGE**

**Department of Engineering  
SRC CASE STUDENTSHIP  
IN FLUID DYNAMICS**

Both the large chemical reactor with its rotating impeller and the stirred pot on the kitchen stove use swirling turbulent flows to accelerate mixing and chemical reaction. Since the mechanics of this age-old process are still poorly understood, we are looking for an engineer or physicist to measure the velocities with a laser doppler anemometer in similar laboratory flows and analyse the result using current theories and computational models of turbulence. The project will be undertaken in collaboration with ICI Ltd, Plastics Division, and will be supervised by Dr R. E. Britter and Dr J. C. R. Hunt. Further information and application forms may be obtained from the Secretary, Faculty of Engineering, Trumpington Street, Cambridge CB2 1PZ.

## Laboratory Technician

G. D. Searle is a leading pharmaceutical company with its main UK headquarters at High Wycombe in Buckinghamshire.

The Biological Development Department currently has a vacancy for a Technician to work on cell culture, viruses and serological assays. Applicants should be qualified to HND, HNC or IMLT level.

A competitive salary is offered, and conditions of employment include 4 weeks holiday per year, contributory pension fund, subsidised private health insurance, sports and social club, and cafeteria.

Please apply to Miss D. Wardman, Assistant Personnel Officer, R. and D. Division, G. D. Searle & Co. Ltd., Lane End Road, Sands, High Wycombe, Bucks. (Tel. High Wycombe 21124, Ext. 3374).

## SEARLE

## UNIVERSITY OF YORK

Department of Computer Science

### SRC CASE RESEARCH STUDENTSHIP

The Department is conducting research into real-time computer systems involving data acquisition, transmission and processing.

Applications are invited from candidates with a good honours degree in engineering or science who wish to research in the area of

### COMPUTER ASSISTED TECHNIQUES IN FIBRES PRODUCTION

It is proposed to investigate how a computer coupled to a closed circuit television system might be used to monitor the quality of production of synthetic fibre yarns and fabrics. This is a collaborative project with ICI, Fibres Division at Harrogate.

The successful candidate will be expected to register for a higher degree. The SRC case award is tenable for three years and the value in the 1979/80 year is £1820 p.a. (tax free); this will be supplemented by a grant of up to £735 p.a. (tax free) provided by ICI. The level of supplementation will be determined by the qualifications and experience of the candidate appointed. Candidates must satisfy SRC conditions of eligibility. Applications from undergraduates in their final year of study will be welcome.

Further details and application forms can be obtained from

Dr A. J. Willmott  
Department of Computer Science  
University of York  
Heslington  
York YO1 5DD



ICI  
Fibres

# UNIVERSITY OF NEWCASTLE UPON TYNE School of Physics RESEARCH STUDENTSHIPS IN GEOPHYSICS & PLANETARY PHYSICS

PhD studentships are available, commencing in October 1980, for graduates with First or Upper Second Class Honours in either: Physics; Geophysics; Astronomy; Geology; Chemistry or Mathematics.

Current research interests are: Evolution of Planets; Fluid Dynamics; Geochronology; Geomagnetism; Geophysical Electronic Instrumentation; High Pressure Geophysics; History of the Earth's Rotation; Palaeomagnetism; Plate Tectonics; Rift Systems; Rock and Mineral Magnetism; Study of Lunar Samples; Submarine Cable Currents.

For further particulars, please write to Mr. J. M. Walsley, Administrative Assistant, School of Physics, The University, Newcastle upon Tyne NE1 7RU.

## FELLOWSHIPS GRANTS SCHOLARSHIPS

IMPERIAL  
CANCER RESEARCH FUND

## RESEARCH FELLOWSHIP

Postdoctoral Biochemist to join a group working on the mechanism of action of the bisdioxopiperazine group of anti-tumour agents. The work would involve a study of biochemical aspects of the nature of induced resistance to the antitumour drug ICRF 159 in a variety of cell lines. Special experience in cell culture techniques, cell hybridisation, 2D-gel electrophoresis etc., would be an advantage.

Appointment will be for three years. Salary range £6228 to £7672 according to qualifications and experience.

Further information from Dr A. M. Cragg (01 242 0200 ext. 284).

Applications with curriculum vitae and names of two referees should be sent to The Secretary, Imperial Cancer Research Fund, Lincoln's Inn Fields, London WC2A 3PX, quoting ref. 93/80. Closing date 22 February, 1980.

## UNIVERSITY OF BIRMINGHAM

Department of Genetics

### RESEARCH FELLOWSHIP

Applications are invited for an SRC-funded Postdoctoral Research Fellowship concerned with the biochemical genetics of natural selection for enzyme activity in experimental populations of *Drosophila melanogaster*. Applicants should be experienced in one or more of the following areas—animal cell/enzyme biochemistry; biochemical genetics; molecular biology; separation techniques or experimental population genetics.

The post is tenable for three years from 1 March, 1980. Salary will be on the RPIA scale £4535-£7521, plus superannuation. Maximum starting salary will be £4910.

Further particulars are available from the Assistant Registrar, Science and Engineering, University of Birmingham, PO Box 363, Birmingham B15 2TT, to whom applications (three copies) including a curriculum vitae and naming three referees should be sent by 31 January, 1980.

Please quote ref: NSLB.

# Atlas Research Fellowship

## St. Catherine's College, Oxford University

The Rutherford and Appleton Laboratories of the Science Research Council and St. Catherine's College invite applications for a joint Research Fellowship. The aim of this "Atlas Fellowship" is to encourage theoretical studies, particularly those involving computers, in an area of research supported by the Rutherford and Appleton Laboratories. These include the following broad fields: study of condensed matter by scattering of neutron beams; elementary particle physics; study of dense plasma by the use of intense laser beams; use of electron beam lithography in the fabrication of semi-conductor devices; image processing computer aided design including electrical circuit design; finite element calculations; electro-magnetic systems. The successful candidate will be expected to undertake independent research work and have ideas on the programme he/she wishes to follow.

The Fellow will have the right and privileges of a Research Fellow of St. Catherine's College including the possibility of some teaching. The Fellow will be provided with an office at St. Catherine's College, but will be expected to spend the greater part of his/her time at the Rutherford and Appleton Laboratories, and will be given access to exceptionally powerful computer facilities. The Rutherford and Appleton Laboratories' involvement with numerous University research groups gives an opportunity for contacts with other research workers engaged on a wide range of exciting research programmes.

The Fellowship will be tenable for a period of three years and may be extended up to a period not exceeding five years. The stipend will depend upon the age and experience of the candidates selected within the broad range £6,200 to £11,300. The Fellowship will carry the superannuation provisions under the SRC Principal Superannuation Scheme which is a non-contributory scheme.

For details of Research Fellows' rights at St. Catherine's College and application forms, write to the Personnel Group of the Rutherford and Appleton Laboratories, Chilton, Didcot, Oxon OX11 0QX, quoting reference no. VN848. The closing date for applications is 31st January, 1980.



## Rutherford and Appleton Laboratories

### UNIVERSITY OF WARWICK POSTDOCTORAL RESEARCH FELLOWSHIP IN INORGANIC CHEMISTRY

Applications are invited for a SRC Research Fellowship in the Department of Chemistry and Molecular Sciences for work on preparative and structural aspects of compounds containing unusual intermolecular interactions, particularly involving iodine and tellurium. This is in conjunction with Dr N. W. Alcock. Appointment is for one year in the first instance, with the possibility of renewal. Salary up to £4510pa on the Research Range 1A scale: £4335-£7521pa (under review). Application forms and further particulars from the Academic Registrar, University of Warwick, Coventry CV4 7AL, quoting ref no: 20/SA/79. Closing date for receipt of application is 15 February, 1980.

### QUEEN MARY COLLEGE University of London High Pressure Crystallisation of Polymers

Applications are invited for an SRC-supported postdoctoral RESEARCH FELLOWSHIP for work with Dr C. K. L. Davies on the above topic. Candidates should have background in polymer/materials science and preferably with experience in X-ray diffraction and electron microscopy techniques. The Fellow may be required to spend time in collaboration with Professor A. J. Pennington at Groningen University. Appointment for three years (commencing not later than 30 June) with initial salary in range (under review) £5073-£5650pa (including London Allowance). Please apply with curriculum vitae and names and addresses of two referees to The Secretary, (NS) Queen Mary College, Mile End Road, London E1 4NS.

### UNIVERSITY OF DURHAM

Department of Psychology

Applications are invited from candidates with research experience in psychology or another scientific subject, for

### A RESEARCH FELLOWSHIP

to work with Professor M. J. Morgan on an MRC funded project concerned with the visual perception of movement. The successful applicant will be expected to acquire skills that include the computer programming of visual displays. The appointment will be for three years from a date to be agreed. Initial salary £4535 per annum on Range 1A plus superannuation. Applications (three copies) stating the names of three referees should be sent by 1 February, 1980, to the Registrar and Secretary, Science Laboratories, South Road, Durham DH1 3LE.

## UNIVERSITY OF NOTTINGHAM

### Department of Physiology and Environmental Studies (Soil Science)

Cycling of sulphur in crops and soils

### Applications are invited for a POST-DOCTORAL RESEARCH FELLOWSHIP

for at least two years, financed by the Central Electricity Generating Board and tenable at the School of Agriculture, Sutton Bonington. This is to work on the fate of atmospheric sulphur dioxide when it reaches the soil, and is likely to involve measurements of drainage losses in the field, lysimeter studies and laboratory investigations of soil sulphur dynamics.

Applicants should have a sound background in physical science and soil science or environmental chemistry, with postgraduate research experience in an appropriate field. The starting salary will be in the range of £835-£4010.

Applications indicating qualifications and research experience should be submitted in writing to Dr D. V. Crawford, University of Nottingham, School of Agriculture, Sutton Bonington, Loughborough LE12 5RD, by 31 January, 1980.

## SERVICES

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CRANFIELD INSTITUTE OF TECHNOLOGY  
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## INSTITUTES OF PSYCHIATRY, NEUROLOGY AND OPHTHALMOLOGY

(British Postgraduate Medical Federation, University of London)

### MSC in NEUROCHEMISTRY

This is a ONE-YEAR COURSE

leading to the degree of MSc in Neurochemistry. It offers graduates in science and medicine training in basic and applied neurochemistry. The Course consists of lectures, seminars and laboratory work and, in the second and third terms, research on a neurochemical topic.

Applicants should have a First or Second Class Honours degree in Biochemistry or a cognate subject, or be medically qualified. The Course is recognised by the Medical Research Council as an Advanced Course for the award of Training Scholarships to suitably qualified applicants.

Applicants for the Academic Year October 1980-July 1981 should be addressed to the Secretary, Course in Neurochemistry, Department of Biochemistry, Institute of Psychiatry, De Crespigny Park, Denmark Hill, London SE5 8AF, England.

### UNIVERSITY COLLEGE LONDON

The College will again offer a one-year advanced course leading to the University of London

### MSC IN CONSERVATION

Applicants will normally be expected to have obtained a first or good second class honours degree in Biology, Botany, Geography, Geology or Zoology. Other qualifications will be considered if applicants can show a strong interest in the field. The course is recognised for the tenure of NERC Advanced Course Studentships.

The course begins in early September and runs for one year. Closing date for applications: 15 February, 1980. Particulars and application forms from The Registrar, University College London, Gower Street, London WC1E 6BT.

Scientists, Technologists, and Engineers, Cranfield MSc and PhD programmes are designed to fit you for responsible positions in industry.

Intensive one year MSc's by project and coursework are offered in:

### METALS ENGINEERING POLYMER ENGINEERING OFFSHORE ENGINEERING WELDING TECHNOLOGY

To applicants with a good Honours degree (or equivalent) or with appropriate industrial experience. A preliminary foundation year is undertaken by those with a Pass degree, HND or equivalent.

Substantial awards are available to suitably experienced, qualified people. For details of courses, housing, grants, etc. contact: Professor R. L. Apps, Department of Materials, Cranfield Institute of Technology, Bedford MK43 0AL.

Tel. 0234-750111 Ext 278.

## IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY CENTRE FOR ENVIRONMENTAL TECHNOLOGY

### M.Sc. ENVIRONMENTAL TECHNOLOGY 1980/81

### ECOLOGICAL MANAGEMENT ENERGY POLICY MINERAL PRODUCTION AND THE ENVIRONMENT POLLUTION POLLUTION AND SAFETY CONTROL ENGINEERING WATER RESOURCES MANAGEMENT

Six specialist options being offered as part of the one year postgraduate and post experience course at the interdepartmental centre for environmental technology at Imperial College.

Course starts with a series of core subjects covering physical environment, applied ecology, urban technology, mineral resources, energy, environmental economics and policy, operations research, computing, and sources and choices of technology.

In the second term students specialise in one of the six options above.

The remainder of the year is devoted to a research project. Projects done in conjunction with outside bodies are welcomed.

The course is open to science and engineering graduates and other suitably qualified students, both from UK and overseas. Post experience students may divide the course between two academic years.

NERC, SRC and SSRC have approved the course for tenure of their advanced course studentships.

Applications: 1 April 1980.

Further particulars from The Registrar, Imperial College of Science and Technology, London SW7 2AZ.

### UNIVERSITY OF LONDON MSC IN RADIATION BIOLOGY

Train to study the biological effects of radiation.

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Applications, together with the names of two referees, should reach the course coordinator, Professor Patricia J. Lindop, Department of Radiobiology, Medical College of St Bartholomew's Hospital, Charterhouse Square, London EC1M 6BQ, as soon as possible.

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### UNIVERSITY OF NOTTINGHAM

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Applications are invited from graduates in appropriate subjects (normally in Agricultural, Biological, Chemical or Veterinary Sciences) for admission to an advanced course of study leading to the degree of MSc (by examination) in Meat Science. The course, which is of one year's duration, includes Production of Meat Animals, Physiology of Meat Animals, Animal Health and Meat Inspection, Sensory Science of Meat and the Economics and Marketing of Meat. The course is designed to provide those having appropriate scientific training with specialist knowledge of meat whereby they would be suitably qualified to accept responsibility for the scientific control of meat as a commodity in relation to agreements with EEC and in world trade generally.

For suitable UK applicants, scholarships may be available.

Those seeking admission for the 1980-81 session should write before 1 March, 1980, requesting an application form, from the following: The Secretary, (ref: PG-P) School of Agriculture, University of Nottingham, Sutton Bonington, Loughborough, Leics LE12 5RD.

### REFLECTED LIGHT MICROSCOPY: AN INTRODUCTORY COURSE

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# ARAB SUMMER SCHOOL

## ON SCIENCE AND TECHNOLOGY 1980

### MINICOMPUTERS, MICROPROCESSORS AND THEIR APPLICATIONS

Following up on the first two sessions held last summer, the school will hold its third session this coming summer (1980) in the field of minicomputers, microprocessors and their Applications. Informations are as follows:

**Objectives:** To provide Arab scientists with state-of-the-art Knowledge in Minicomputers, Microprocessors and their Applications, and create a forum of contracts and interaction between Arab scientists.

**Topic:** Minicomputers, Microprocessors and their Applications. A tentative list includes:

- I. Introduction and over-view.
- II. Technologies.
- III. Basic Architecture of Minicomputer and Microprocessors.
- IV. Peripherals and Interfacing. (mc and  $\mu$ p).
- V. Languages and Implementation.
- VI. Operating System and System Development Aids.
- VII. Applications Overview and Practical Considerations.
- VIII. Computation Applications.
- IX. Minicomputer and  $\mu$ p in dedicated Systems.
- X. The present use of minis and micros in the Arab World.
- XI. Perspectives.

(programme is subject to minor modifications).

**Date and Place:** 28 June–11 July, 1980. Bloudan, Syria. (Bloudan is an attractive summer resort, located near Damascus, Syria).

**Speakers:** Internationally recognized scientists in the fields of Minicomputers, Microprocessors and their Applications, chosen from the USA, Europe, and the Arab World.

**Participants:** About 50 professors, Scientists, and engineers active in Minicomputers, Microprocessors and their Applications research and planning.

Persons to be chosen primarily from the Arab World. Also few openings exist for scientists of Arab origin working abroad, and for scientists from Islamic Countries.

**Language:** English.

**Sponsors:** Kuwait University, Kuwait Institute for Scientific Research, and the Supreme Science Council (Syria).

**Scholarships:** A limited number of scholarships, covering transportation, lodging, and meals will be available.

The final list of topics, and names of speakers will be provided in a later announcement. For application forms and further information contact:

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# Ariadne

■ One of our authors writing in the Christmas issue is in trouble and, in case he hasn't been able to reply himself I am arrogantly pre-empting the subject.

It's the old one of the decade. Whether it begins in 1981 or we're in it now is the question that has exercised readers. Not that there has been a rush of galloping nit-pickers over the horizon, bearing down on us with their dreaded split hairs. Far from being purple-faced and vituperative, mostly they apologise for bringing the subject up—"You may think I'm being pedantic", "Sorry to re-skirmish over bitterly fought ground" and so on.

My position is simple. I don't think that it matters a damn. And that goes for the Council of Nicaea who established the Christian epoch at the year 1. Any person of ordinary common sense and virtue knows that he, when he starts using years with 8 in them, the 7s are finished and that shows a new ten years stretches ahead. It's accepted, fellers. Who would lose any sleep over that? Don't forget to write again in 1990.

■ Over the recent holiday, I was looking through the first volume of *The Strand* magazine, which began life in 1891. There was little of anything but quaint interest until I came across what must be the first short story by Conan Doyle. What attracted me was its title, for obvious reasons. It was "The Voice of Science".

Rose Esdaile is well-known to have £500 a year in her own right. Mrs Esdaile, her mother, is a leading light of the local Eclectic Society who keeps up with scientific developments. Rupert Esdaile, the son, is opposed to Captain Charles Beesly, who is hoping to marry Rose. "Do be a sensible girl," says Rupert, who thinks that Beesly has nothing to recommend him but his eyes and his moustache. Rupert has been talking to young Cheffington of the Gunners, who knew Beesly in India.

So much for scene setting. On this particular evening, Mrs Esdaile has a phonograph on show. With "languid curiosity" Rupert examines this and then has a great idea, signalled by a slap of the thigh and a dance round. He takes "virgin metal plates" and the machine into his own room and then returns the phonograph ready for demonstration.

The company forms an expectant circle round the instrument. Switched on, the phonograph inquires, "How about Lucy Araminta Pennyfeather?" Beesly receives this with "a drooping jaw, two protruding eyes and a face the colour of cheese". "How about little Martha Hovedean of the Kensal Choir Union?" the phonograph asks inexorably. "Who was it who hid the ace in the artillery card-room at Peshawar?" This is too much for Beesly. "There he goes," says Rupert, "cutting down the avenue as fast as his legs will carry him." Rose has been saved by applied science and you can't say fairer than that.



■ People in the know motor to Wilton, the famous carpet metropolis, taking a sketch of the area they want covered. With a bit of skill at jigsawing, they can pick up enough off-cuts and bits left over from rolls to make up a whole carpet. But they are not so well treated as they used to be. The firm has a computer that, at first, was incompetent and produced odd lengths in great quantity, thus causing the roads to Wilton to carry a relatively heavy traffic of cars filled with people clutching scraps of paper and debating about the merits of carpet in the bathroom.

Now the computer has become a lot better at its job of rationalising production, so the left-overs are disappearing. End of trade in half-price carpet, luxurious, kind to the feet.

Progress is not always at the same rate and in the same direction for everybody.

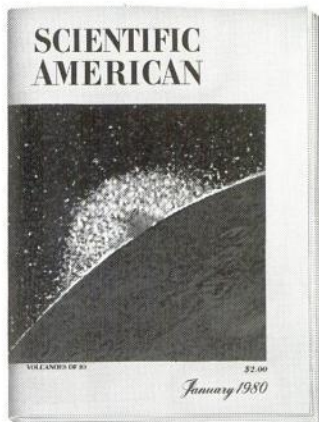
■ The process of invasion by the trendies into parts of London that were previously strongholds of the distinctly untrendy has been named "gentrification" by the disgruntled. There is more than one form of it. I have seen a legend from the prolix, pompous section, on a van. "Quality Replacement Automotive Components". If it catches on there are going to be problems in headlines for spare-part surgery.

■ My biolaminar friend Daedalus points out this week that all the ritual devotion of washing and polishing the car is misplaced. Rust always eats through from the inside, and it's the underseal which should be renewed. He recalls the way some micro-organisms protect themselves from heavy metals in solution. They reduce the threatening ions to bulk

metal which accumulates as a little nugget inside them—indeed there are schemes to exploit this in microbial mining. So Daedalus is inventing a biological underseal which, as fast as the metal rusts, will reduce the ferric ions back to metal. Plants or green algae would be poor candidates for this invention, as they need lots of light, but fungi and marine fouling organisms look more hopeful. In particular barnacles, etc, bond themselves to metal by a glue stronger and more durable than any industrial product. So Daedalus is culturing suitable barnacles, fungi, and other surface parasites with those magnetic bacteria which may produce internal iron-fillings for navigation purposes. By threatening these cultures with increasingly concentrated ferric solutions, and bathing them in mutagenic radiation, he hopes to induce a symbiosis in which the surface-dwellers employ the metal-reducing bacteria to mop up the ferric ions as metal particles. As the generations of organisms decay in succession they will fertilise their successors, except for a growing substratum of iron particles bonded by organic glue. As fast as this underlayer is attacked by rust it will be biologically renewed. Mud and spray thrown up by every car journey will shower more nutrients on this rust-defying automobile internal garden.

Once the ecology of such multi-organism biological paints has been established, many other industrial artifacts besides cars will benefit. But nutrient sources may then be a problem. Coating the Forth Bridge with a rust-cancelling biological culture would be economically unattractive if the painters thereafter had to keep covering the structure with chicken soup.





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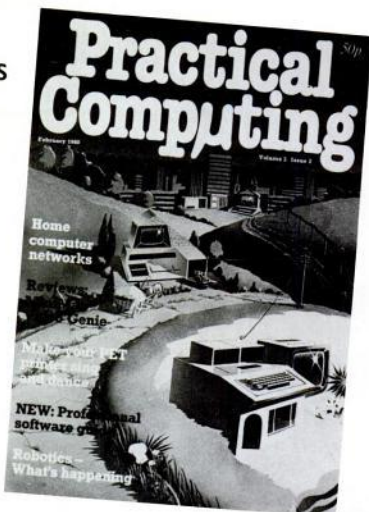
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